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THE CANADIAN URBAN SYSTEM: A STATISTICAL STUDY OF ITS ECONOMIC CHANGES BETWEEN 1971 AND 1981.

by

©

WIESLAW Z. MICHALAK

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ABSTRACT

The objective of this thesis was to describe and examine the Canadian urban system through the analysis of the economic structures of all urban places of over 10,000 inhabitants in Canada. This examination focused on the changes to the economic dimensions associated with the cities of this system between 1971 and 1981. To achieve this goal, selected demographic, labor force and employment variables at two censuses were examined for each urban place, by means of factor analysis. Then, factor loadings extracted from the data matrices were interpreted in order to determine the basic economic dimensions of the Canadian urban system at each point in time. A comparision of the economic dimensions in 1971 with the economic dimensions in 1981 enabled the isolation of structural changes in the dimensions of the Canadian urban system as a whole.

In 1971 four economic dimensions were identified. They were: white-collar, service-administrative character of metropolitan centers of Canada, high female employment in manufacturing and low unemployment in the secondary sector, frontier-service centers and specialized manufacturing centers. In 1981 the dimensions were: metropolitan, white-collar, service-administrative character of the major urban centers of Canada, high labor force participation ratio in manufacturing, manufacturing centers of the industrial heartland of Canada and high rate of the population change associated with high employment in sales and construction sectors.

The analysis of the dimensions revealed that they remained partially stable between 1971 and 1981. In particular, the first dimension - white-collar, tertiary employment - remained the same. A closer examination showed that the dimension indexes a process of urban concentration and progressive economic diversification of the Canadian cities, paricularly in the industrial heartland and the Prairie Provinces. The rest of the dimensions showed a very strong regional association between the employment structures of cities and their distribution in geographical space.

All of the findings in this thesis account for a substantial economic shift within the Canadian urban system between 1971 and 1981, even though the major economic dimensions of this system showed a much lesser degree of dynamics. In particular, the spatial change in the distribution of employment profiles within the system is noticeable. However, the study revealed the major deficiency of the urban systems approach which is the lack of a well-defined framework for empirical investigation.

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I. INTRODUCTION

All urban places in the world are part of an integrated urban network. The contemporary settlement pattern is the result of a long evolution that has been caused by various economic, political and institutional factors as well as by the diffusion of innovations and technological developments (Friedmann, 1973). During the last few years research in the field of urban geography has moved from purely empirical studies towards a system analysis framework. Most of the contemporary authors acknowledge that the presence of strong interactions among a set of elements (i.e. cities) in a bounded area (i.e. nation or region) and the existence of feedback effects which regulate growth and change imply the existence of some kind of a system.

In its narrowest most traditional sense, the urban system refers to the set of cities in a region and their attributes such as economic, social and cultural characteristics.The system in this sense is simply a static aggregate of cities. Usually no attempt is made to identify various relationships among them. However as Simmons (1974, p.8) points out:

> "...when developed more fully, the urban system can embrace the totality of activities in a nation, account for the observed relationships among regions and provide a model of growth and change in the system."

In this sense the urban system is still based on urban nodes, that is spatial concentrations of people and activities within a nation. However, it is also concerned with the relationships of these nodes to the other nodes of the system.

Urban places forming an urban system differ in their socio-economic structures and roles they play within the urban system. The considerable differences in their structures may be caused by numerous factors i.e. their population size, location in geographic space, a transportation network, political system, economic fluctuations and so forth. The enormous complexity of socio-economic variables emerging from any analysis is usually difficult to conceptualize and explain. Therefore, the concept of the urban system has been adopted in this thesis as a tool which will simplify the existing urban network in Canada to allow more comprehensive research. The precise definition of this system depends solely on the objective of the research undertaken. Thus, before a definition of the Canadian urban system is given, the concept of a system itself will be examined in more detail.

1.1 Definition of a System

As postulated by L.von Bertalanffy (1950), all things (physical objects as well as ideas) have connections with many other things and the significance of any one depends on its relationships with others. Therefore, the unit of study should be not a single thing but a system of interrelated objects or ideas. Hence, a system is a set of interrelated parts. Probably the most quoted definition of a system is that of Hall and Fagen (1958, p.18):

> "A system is a set of objects with relationships between the objects and between their attributes."

Thus a system has at least three basic ingredients: elements, states and relations between elements and/or states.

In geography a definition acceptable for our purposes has been given by Chorley and Kennedy (1971, p.52). A system is:

> "... a structured set of objects and/or attributes. These objects and attributes consist of components or variables (i.e. phenomena which are free to assume variable magnitude) that exhibit discernible relationships with one another and operate together as a complex whole, according to some observed pattern."

The elements or components of a system are either physical objects (eg. towns or soil types), or concepts (eg. words, numbers and the like). According to Huggett (1980), physical objects are components of concrete systems whereas concepts are elements of abstract systems. This distinction is of great importance since urban geography deals with both concrete (physical) and abstract systems at the same time. For example, the network of highways connecting urban centers together is a physical, concrete, actually existing system, while a network of central places is an abstract system created for heuristic purposes.

Each system element has a set of properties, attributes or states i.e. number, size, price and so forth, each of which is called *a state variable* (Huggett, 1980, p.15). The system's state is defined by the values of the state variables at a particular point in time. Therefore, the state of a system as a whole may be given by determining the aggregate state of its elements at a particular point in time.

The major attribute of a system defined in this way is that it imposes a structure on a set of elements which at first glance are random. It can be argued whether this *structure* is an objectively existing pattern or a subjective concept superimposed on the set of random elements. Harvey (1969) has described *systems* as mental constructs that facilitate a certain style of analysis, while Emery and Trist (1965) have pointed out that they are the most appropriate conceptual response when to understand the nature of interdependencies constitutes the research task. However, this problem is beyond the objective of this discussion.

So far, the definition of a system in geography does not differ significantly from these formulated in other sciences.The definition becomes an exclusively geographical one when the concept of geographical space is introduced. In this case, the general definition of a system is narrowed into the definition of a spatial system. Since a spatial system is comprised of a set of elements existing in a geographical space, it implies that systems are bounded, because they are usually defined in such a way that there is a limited number of elements (at least theoretically). The variables which define the state of the system within itself are called endogenous variables; those outside are exogenous. Therefore, the endogenous variables are directly relevant to the state of the system, while the exogenous variables influence the state of the system indirectly through external changes. Systems which lack exogenous variables are said to be unforced systems since there are no external influences upon them (of course such systems exist only theoretically, i.e. models). Those systems with exogenous variables are forced systems.

The attributes are assumed to be variables which describe properties of elements comprising the system at a particular time. However, an urban system can have an infinity of variables measured on any object within the system at any point in time.

Thus,

> "If any real system is modelled in terms of variables, we can have an infinite number of models (or levels) of that system, and then the model system behaves (over time), as much in response to its own definition as it does to the system being modelled."(Chapman, 1970, p.80).

For the purpose of research, systems are normally defined in terms of three levels:

- the level of interest, or the system itself
- a level within, or the system components
- a level without, or environment (Simon, 1962).

These theoretical levels enable one to differentiate between the complex substructures and subsystems within the system as a whole. For example, the level of interest or the system itself may be defined as a flow of goods and decisions among the entire population of cities which is, in turn, related to the communication and transportation network. Thus, the system of interest in this case would be the communication and transportation network.

The level within is the lowest network in terms of scale, which is related strongly to the previous one, for example, the social or economic relations between individual towns and cities within the system. The system is defined in terms of its components, where each community is considered separately with relations to the rest of the components. And finally, the system without or environment representing the highest level of generalization. It encompasses the international and national relations between urban places on national or international scales. Thus, the system can be defined as a network of cities together with the various interrelations among them in Canada or North America as a whole.

1.2 Definition of an Urban System

The concept of the urban system or the system of cities was introduced in the studies of early writers such as Gras (1922), Christaller (1933), Losch (1937), Harris and Ullmann (1945); however, relatively recently it has been applied on a larger scale in the works of geographers. The term ***urban system*** has been broadly accepted in geographical research since 1960, and was introduced by Duncan, Perloff and Berry (Duncan, et al., 1960, Perloff, et al., 1960, Berry, 1966). However, there is no clear agreement on exactly what the phrase means. There have been numerous attempts at defining what are the most important features of an urban system and how it operates or behaves through time. Certainly, the research applicability of the concept is thus limited.

Pred wrote:

> "...a system of cities is defined as a national or regional set of cities which are interdependent in such a way that any significant change in the economic activities, occupational structure, total income or population of one member city will directly or indirectly bring about some modification in the economic activities, occupational structure, total income, or population of one or more other set members" (Pred, 1977, p.13).

In this respect the urban system is a particular case of a more basic ***complex social system***. As such it is a forced system where exogenous elements are those which influence the change within the system from outside. In the case of the Canadian urban system, the most obvious exogenous influences come from the American urban system. That is, some of the units or elements (urban places) belonging to the system interact directly with elements outside the system. Therefore the changes occurring in the Canadian urban system may be affected by the processes occurring in another urban system.

The definition formulated by Pred is an example of the most common approach towards the problem of the urban system found in the geographic literature. Bourne and Simmons (1973, p.3) for example defined the urban system as:

> "...a set of interdependent cities comprising a region or nation."

This definition does not differ from the previous one in terms of its basic elements. The national urban system is limited by the political borders of a nation; it is comprised of interdependent cities of various sizes and economic structures. These observations can be found in much of the recent literature.

The difficulties arise, however, when the theoretical formulation of the concept is transposed into operational terms. The bounding of urban areas usually becomes an enormous problem, questioning the utility of the urban system concept. One of the alternatives to the urban system notion is the concept of functional economic regions which fully occupy the space-limits of the area under study, eg. nation. Therefore, the problem of boundaries in urban areas is avoided since each urban place is defined in terms of not only its municipal borders, but also a surrounding rural area (Berry, 1971).

The application of the functional region as a basic unit for research avoids the main definitional problem of the boundaries of a city. However, there are some limitations to it. The city is defined only on the level of interaction with its region and smaller urban areas. There are no recognized linkages at other levels such as the national level or the system within. Moreover, there are no scale differences among the regions since all of them have more or less the same relative economic and political position. Therefore, the notion of *the city* vanishes in the theoretical models drawn on economic theories of regional trade and growth.

None of the two concepts of city boundaries outlined above can account for all of the complex processes occurring at the national scale and having an impact on the urban system. However, since the city's areal extent can be established readily at any point in time, the concept of a bounded urban area seems to be the only one for spatial analysis. The major advantage of this concept is that it narrows the urban area to a specific spatial unit which can be compared or examined with non-urban or rural geographical regions for statistical purposes. Therefore, this concept will be used in this thesis as the basis for data collection.

Consequently, the urban system is defined in this thesis as a set of interdependent urban areas (cities or towns) comprising a region or nation, together with the relationships between them. The cities themselves are reduced in scale to points located within the region. A threshold population and density of this location differentiate the urban area from the non-urban, rural area.

1.3 Evolution of an Urban System

Any urban system is subject to constant evolution through time. This change is the result of the complex economic, political and social processes occurring within its structure. Evolution is defined in this case as any change (positive or negative) between two points in time of the variables selected to measure the economic structure of the system of cities. An examination of these changes as expressed by the socio-economic variables is one of the most essential aspects of urban systems research. A better understanding of the changes and consequently the evolution of an urban system over time, is a fundamental condition to further progress in urban geography. Having defined the urban system, the question which arises now is what theoretical framework can be applied in order to examine the economic changes actually occurring in an urban system ? Unfortunately, the body of knowledge in this area is still largely intuitive and inconsistent. Therefore, any comprehensive review of the literature in this field is difficult.

Systems theory considers an ideal, theoretical case of a system where its elements have *n* sets of properties or states measured continuously through time which comprise an *n* dimensional phase space defined by certain co-ordinates; one for each variable (Figure 1.). If the state of the system should change with time, a pattern of change will be traced through the phase space. The direction of this change will depend upon the relations between the system components. In the existing urban system, the change depends on the various socio-economic processes occurring simultaneously at different levels of interaction between the urban places. The direct and indirect results of these complex processes can be measured as economic characteristics of the urban places at different points in time. Theoretically, by examining these economic variables by means of some appropriate technique (for example a multivariate statistical analysis or shift-share analysis), the dynamics, that is, the pattern of change or growth of the urban system through time, can be determined.

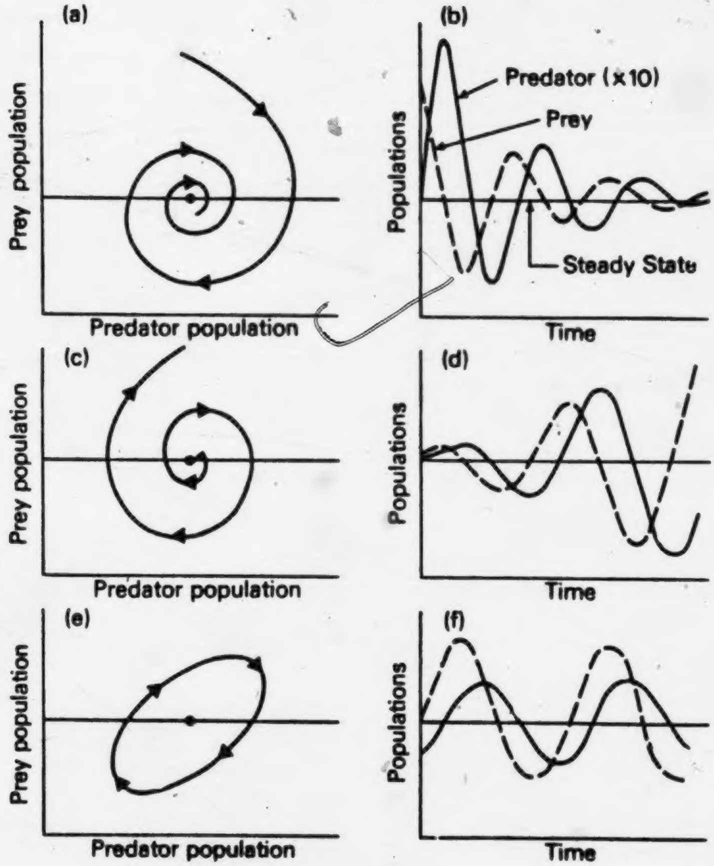
Huggett (1980, p.4) defines three ideal cases of the system:

1. The system state may move towards a point or mode in the phase space, which is

Figure 1. Types of system stability shown by a Predator-Prey system. The figures on the left show the system dynamics within a phase space; the figures on the right show system changes through time: (a) and (b) show stable dynamics; (c) and (d) show unstable dynamics; (e) and (f) show cyclically stable dynamics.

Phase Space

System Changes


(a)
Prey population
Predator population
(b)
Predator (×10)
Prey
Populations
Steady State
Time
(c)
Prey population
Predator population
(d)
Populations
Time
(e)
Prey population
Predator population
(f)
Populations
Time

Predator-Prey: Urban Places

Source: Huggett, 1980, p.5 (modified).

independent of the initial state of the system and in which state the system tends to remain. In this steady state and in this condition, the system is said to be stable (Figure 1.a). In fact the relations between elements determine that this system moves to the steady state through a series of damped oscillations (Figure 1.b).

2. The system state may move away from a point in the phase space, in which case the system is said to be unstable (Figure 1.c). Thus, the system becomes unstable through a series of oscillations of increasing magnitude (Figure 1.d).
3. The system state may circle a point in the phase space (Figure 1.e), in which case the system will exhibit periodic or cyclical fluctuations around a steady state (Figure 1.f).

The urban system at each level of study (for example at the national, regional or sub-regional level) displays a degree of autonomy over its component parts and over its environment. The autonomy is achieved in part by the system at a given level of functioning and at a different space and time scale from systems at other levels. Thus, the pattern of economic change on the level of the regional subsystem is less complex than that of the national scale. The changes in the national urban system level pass virtually unnoticed at the regional level. Therefore, the national system from this perspective appears to be in a steady state even though on the regional level it is not. In other words, the result of an analysis of the urban system depends on the level of generalization of the area of enquiry. Still, findings considering the national urban system may be far different from those on the regional system scale.

The dynamics of an existing urban system, that is, the continuous pattern of change within the system is very difficult, if possible at all, to measure quantitatively. Firstly, it is difficult to find enough economic data measured on an annual or even better monthly basis. Therefore, the researcher has to content himself with the census data provided at the best on a five or ten year basis. Secondly, even if such data were available the difficulties with handling and interpreting such large matrices would exceed the possible benefits of the whole research. As a result, most of the studies on urban systems tend to be based on the comparative statistics approach, which will be adopted in this thesis.

The comparative statistics approach is based on economic variables measured at two or more points in time. By comparing the two times by means of some appropriate technique, the changes in the variables can be determined. As it has been said already, these changes reflect the economic change (if any) within the system. At this point the problem arises of a technique by which the data are to be analyzed and compared. Considering the number of variables and cases to be tested in the study, the most suitable technique is factor analysis. This technique offers a fruitful approach to condensing voluminous sets of data (such as the data to be used in this thesis) into a relatively few useful indices or dimensions. As Isard pointed out:

> "...factor analysis can serve to reduce a mass of undifferentiated data to a limited number of variables consistent with the investigator's hypotheses. Thereby it can suggest useful typologies and classification schemes and identify workable social groups, workable regions, and workable aggregates of units of various sorts."(Isard, 1960, p.685).

Such an approach requires certain assumptions or hypotheses to be made before the factor analysis is performed, as to the direction and magnitude of changes in the data matrices between two points in time.

Korcelli (in: Hansen, et al., 1978, p.232) has pointed out that the urban system has been described and interpreted in two basic ways. Both approaches start from the central place models introduced by Christaller and Losch. The first one may be called a regional approach, since most of the elements of the system relate to the regional dimensions of settlement systems. The most prominent examples of this approach are works by Duncan (et al., 1960) and by Friedmann and Miller (1965). To this tradition belong also the studies of the Canadian urban system undertaken by Bourne and Simmons (1974, et al., 1978, 1979a, 1979b, 1981). The system is evolving in the sequence of spatial patterns which are manifestations of economic, social and political changes occurring through time. Especially, changing proportions among individual economic activities as well as costs of transportation influence the spatial pattern of urban places. When concentration forces prevail the result is a pattern of metropolitan dominance.

The second approach emphasizes the interregional scale of specialization and interaction. The best example of it are the works by Pred (1973, 1977). The basic assumption is that contrary to classical central place theory, the linkages between higher order urban places have a much more important role than horizontal linkages between the lower and higher strata of the urban network. It is claimed that in the course of development of urban systems, regional ties (horizontal) are gradually overshadowed by what could be called *territorially discrete linkages* (Pred, 1977).

> "...for some spatial systems, any two core regions of approximately the same level in the hierarchy will tend to have a greater and more balanced volume of mutual interaction, modified by distance, than either will have with individual lower order cores."(Pred, 1977, p.97).

Conceptually, these two approaches are closely interrelated. As Korcelli points out:

> "...intuitively, the spatial patterns of flows are functions of the activities concerned in addition to being functions of the media involved."(in: Hansen, et al., 1978, p.235).

He suggested that the question of the relative importance of interregional versus regional linkage patterns may be ill-posed. More systematic study is required of complex flow patterns of endogenous variables in order to make any valuable generalizations. Each of the approaches points to certain aspects of spatial interaction which cannot be clearly separated.

It is improbable that any of the existing models, few of which were discussed here, would be universally acceptable. There are too many components and variables interacting among themselves and influencing the growth and change of an urban system. It would be too difficult, if not impossible, to include all of them within a single universal framework.

1.4 Rationale for the Study

There are at least two reasons for undertaking research on the Canadian urban system. Firstly, the process of urbanization in Canada, which is considered to be an inevitable consequence of economic development, is an integral component and generator of economic growth and social change. Therefore, a better understanding of these processes requires a systematic study of Canadian cities.

Secondly, the subject matter of urban growth and change is extremely complex. Perhaps a universally accepted theory explaining all possible aspects of an urban economy is not possible to develop. The numerous studies and theories in this field usually deal with one or at most a few selected problems. Notwithstanding their value, there is still a need for a theoretical framework which will enable the summarizing or at least the ordering, of the research on urban growth and change. This need is met by the urban system framework.

The major advantages of adopting the urban system concept lie in the openness or flexibility of it. That is, its basic components, such as elements (eg. cities), boundary (eg. a region) and linkages (eg. socioeconomic interactions between cities) are broadly accepted in all urban studies as principal features of any urban area of enquiry on an aggregate scale. Therefore, most of the existing urban theories can be adopted as an analytical framework within the urban system conceptual model. On the other hand, the urban system theory can serve as an analytical framework on its own. For example, a study of the behaviour or dynamics of an urban system over time can be considered an analytical application of the urban system concept.

In this thesis the urban system concept has been adopted in order to examine the economic changes of Canadian cities in the ten year period from 1971 to 1981. In order to analyze these changes, the model of urban dimensions (called later in the thesis ***the economic dimensions***) will be applied. A detailed outline of this model will be given in the latter part of this chapter. The combined application of the urban system concept together with the model of urban (economic) dimensions is designed to examine the structure of the cities forming this system.

1.5 The Canadian Urban System

The Canadian urban system is defined in this thesis as being comprised of all urban places of over 10,000 inhabitants within the political borders of Canada. The urban places, together with the network of economic, social and political interrelationships, establish the system as a whole.

Canada is an interesting example of an urban system. It shares all major characteristics of any urban system such as the urban places, diversified economy and linkages among cities. However, it differs significantly from the urban systems of other developed countries. The most striking differences are the vast distances between the major urban centers. The population is small and concentrated in widely separated nodes. The economic activities are specialized into one or two dominant sectors at each location. The pattern of growth and change of any one urban region is largely determined by exogenous variables.

As was indicated earlier, there are considerable difficulties arising from the problem of correspondence between different levels of the urban system. The environment of a region differs significantly from the environment of Canada as a whole. The shifts in the scale of the research profoundly alter the results of any analysis of the relationships between the components of the system. Terminology is usually defined with reference to some assumed scale in space and time. Simmons identified four major areas of possible interest within the Canadian urban system analysis:

1. National urban system.
2. Regional urban system.
3. Urban region.
4. Within city. (Simmons, 1974, p.44).

In this thesis the focus is on the system as a whole. Therefore, this system is something more than a simple aggregate of urban places. Hence, the elements of the system are to be examined in relation to each other. The distribution of properties, such as the percentage ratio of employment in a particular industry, are of interest as well as the covariancies among different industries. In this way the differences and similarities in the economic profiles of each of the populations of Canadian cities can be determined.

The assumption underlying the analysis is that all urban places are closely linked to one another by inputs and outputs (Simmons, 1974, p.12). Therefore, a change in the employment structure of one city is interpreted as the result of changes in all other urban places comprising the system. Within the national urban system each level is composed of the aggregate of cities in the next lower level. Moreover, the whole network is an entity since there are higher level elements which link the lower level network of cities into a coherent system. In this sense the lower level cities of the system, though not directly connected with each other, interact with the other lower level places through the higher level centers. The Canadian urban system is more than just a set of cities. All urban places interact with each other, either directly or indirectly, through their access to the next higher level subsystem. The complex pattern of resulting economic changes is very difficult to describe and explain. In order to handle this task a model of urban dimensions has been adopted as the means for analysis.

1.6 Multivariate Analysis of the Urban System

Multivariate analysis, namely factor analysis, has its origin in psychology at the beginning of the twentieth century. The problem posed was how to convert the theoretical concept of *a general intelligence* into an empirical concept that could be measured and analyzed. The solution was a multivariate model of factor analysis. Later, many social scientists, among them urban geographers, adopted this statistical technique. The major advantage of this technique is that it:

> "...can simultaneously manage over a hundred variables, compensate for random error and validity and disentagle complex relationships into their major and distinct regularities."(Rummel, 1968, p.444).

Factor analysis can be and has been applied to urban studies. It is a particularly useful technique in urban research since it can be used to group interdependent variables into descriptive categories such as socio-economic status of a city or functional size in the hierarchy of cities. Factor analysis can be an effective technique when applied to studies of an urban system. The basic question in this area of research is similar to that in psychology, that is, how the theoretical concept of ***an urban system*** can be converted into an empirical one that could be measured and analysed. Factor analysis reduces a large amount of data into a smaller, easier to handle, number of new variables. This technique yields correlations or loadings between the original data matrix and the sets of new variables which are called factors. An examination of the factor loadings allows empirical interpretations of the factors, henceforth called dimensions. In other words, the interrelations among a set of variables describing a particular state of an urban system are expressed in terms of the dimensions of this urban system. These dimensions are mathematical artifacts describing in the best possible way (within the limits of the technique) the variation of variables describing a particular urban system.

A good example of the application of this technique is the classification of British towns by Moser and Scott (1961). They analyzed 157 towns on the basis of interrelations between 57 variables. The variables were chosen in order to analyze as many socio-economic characteristics of the British towns as possible, without any underlying conceptual framework or hypotheses to be tested. These relationships were summarized in terms of four underlying components identified as: social class, population change 1931-51, population change 1951-58 and overcrowding in the cities. The scores for the 157 towns on these factors provided then the basis for a quantitative classification of the British towns which was the ultimate objective of the study.

Another example is the study of American cities by Hadden and Borgatta (1965). They analyzed 644 cities of over 25,000 people in terms of 65 socio-economic variables. Then four groups of cities were established with respect to population size and three on the basis of the concepts of central city, suburb and independent city. A principal axes factor analysis with orthogonal rotation was employed for analysis of each group of cities and for the total of cities. The results showed a great degree of similarity between most of the American cities in terms of their respective factor scores. The dimensions of socio-economic status, age composition, education centre, residential mobility, population density and wholesale concentration were important for all of the cities analyzed.

The study of Indian cities by Ahmad (1965) is identical in technique to that by Moser and Scott, except that the factor matrix was rotated using a different method (i.e. normal varimax position). Sixty-two socio-economic variables describing the broadest possible spectrum of urban characteristics were reduced on the basis of the rotated factor matrix into ten dimensions. They were: north-south differentiation by sex, contribution and accessibility, commercial and/ or industrial structure, compactness of a city, rural population and population change 1951-61.

The first multivariate studies on the urban system in Canada were undertaken by King (1966). He analyzed 106 Canadian cities in terms of 52 socio-economic variables for each city for the years 1951 and 1961. The dimensions of socio-economic status, primary industry orientation and specialized manufacturing towns were found the most important. The sets of data were analyzed by means of a principal-component technique and Mahalanobis D2 grouping technique.

Another study on the Canadian urban system was undertaken by Ray (et al., 1968), who has restudied this system in terms of a larger set of variables (95) obtained from the 1961 Census of Canada. The selection of variables focused on the broadest possible description of the urban system in terms of its socio-economic characteristics. He found that the English-French contrasts in Canada were the most important dimensions along with several functional types of cities, such as mining service centers, manufacturing and metropolitan growth poles.

Two studies from the University of Toronto focusing on regional differences in the Ontario-Quebec urban system were based on the factor analysis technique. The first one by Bounting (in: Bourne & McKinnon, et al., 1972) has summarized the overall structure of the industrial heartland of Canada by eight dimensions for 1951 and 1961. The most important of them were defined as: diversified centers, specialized centers, commercial and declining centers, Toronto satellites, northern centers, transportation and metropolitan centers.

The second one by Britton (in: Bourne & McKinnon, et al., 1972) is focused on the same regional urban system but it is examined in terms of employment characteristics exclusively. The objective of this study was to develop a classification of cities in Ontario and Quebec on the basis of their economic data. The research design of it includes an interesting experiment based on the application of two modes (R-mode and Q-mode) of factor analysis, in order to test the utility of each of these techniques for the purpose of classification. The conclusion was that Q-mode is more suitable for the purpose of the type of the study undertaken.

The studies reviewed (except that of King, 1966 and Britton, 1972) were not structured around any hypotheses or the testing of any theory. Their major aim was to reduce the number of variables into a more meaningful and an easier to handle, new set of variables called dimensions. In this sense these studies were designed to achieve a more sophisticated type of empirical analysis. The results of the experiments should enable, in the belief of their authors, concentration on the more specific aspects of the urban systems extracted by means of factor analysis. These more fundamental aspects or dimensions should constitute a new area of enquiry in urban system research. For example, Hadden and Borgatta (1965) have pointed out that by applying this technique they were able to focus on a wider spectrum of complexities of the American urban system than in previous studies. Unfortunately, the research in the field of urban systems through applications of factor analysis did not yield a significant contribution to the theory itself. As Berry (1972) has pointed out, geographers have concentrated more on the procedure of the research, rather than on the question of the purpose of the analysis. Especially important is to define the objective of the analysis which should be known before it is performed.

An attempt to overcome these deficiencies was the study on the Canadian urban system by King (1966). On the basis of empirical findings from the previous research by Moser and

Scott (1961), Hadden and Borgatta (1965) and Ahmad (1965), he examined the structure of urban dimensions in Canada in 1951 and 1961. He suggested that there were four major features of the urban dimensions model which warrant further attention.

Firstly, the question of dynamics of the urban system. Does it remain stable or change through time? The hypothesis was that it evolves through time due to the shift of the system towards progressive concentration of economic activities in the major metropolitan centers of the system. Over time dimensions indicating metropolitanization, that is concentration of tertiary and service occupations, communication and transportation and socio-economic stratification, should yield stronger factor loadings in the factor matrix. There also should be a sharp differentiation of these dimensions between cities located within or near metropolitan complexes and the rest of the urban places.

Secondly, even though the factor loadings may not change over time, proving the stationary character of the urban system, the factor scores of individual urban places may vary considerably. As King writes:

> "...these changes would reflect new socio-economic or locational orientations for the cities concerned..."(King, 1966, p.208).

Thirdly, the relative distances between points representing urban places in the orthogonal space defined by the dimensions can be used as indices of the urban places' similarities and dissimilarities. However, if these dimensions change over time then groups of cities may vary according to the new dimensions. The new pattern of spatial distribution can be used for analytical purposes in order to examine the changes in the urban system.

Finally, the basic form of the city system (i.e. its dimensions) may remain relatively stable over time, but the factor loadings of different variables on these factors may vary from one time to another. This situation is possible only when the factors are given very broad interpretations which allow for a great degree of flexibility. Otherwise, the form of the dimensions, if more precisely defined, would be subject to a change together with the factor scores of individual cities.

After examination of the data for 1951 and 1961 by means of the principal-component technique, King came to the conclusion that the Canadian urban system is not stable over time in its basic dimensions. These dimensions in 1951 have been identified as:

> "...youthfulness of the female population, socio-economic character of cities outside Quebec, frontier location and economic orientation, small city manufacturing, suburban occupational and housing structure and metals employment and related housing conditions. In 1961 the important components appeared to be: urban textile manufacturing, Quebec population structure, metropolitan socio-economic structure, high socio-economic residential status, service role of older and comparatively isolated cities, and urban depression."(King, 1966, p.223).

On the basis of these dimensions several groups of cities were defined, which then served to identify, within the total urban system, certain sub-systems which warranted further study. Moreover, the direction and volume of the changes in the urban dimensions over time were used by King as indexes of the major socio-economic processes occurring within the Canadian urban system.

These findings

> "...not only throw new light on the Canadian urban system, but also they complement those of previous studies of urban systems in contributing toward a better understanding of urban structure and the sensitivity of related models to changes in the urban system over time."(King, 1966, p.223).

In this thesis the approach outlined in King's study will be adopted in order to examine the possible changes in the Canadian urban system in the ten year period from 1971 to 1981. To achieve this aim two sets of the demographic, labor force and employment variables for 1971 and 1981 will be examined by means of the principal-component technique. The sets of data in this thesis differ significantly from those of King's study in the selection of variables. The purpose is to reduce the number of variables in order to concentrate on the economic characteristics of the Canadian urban system.

1.7 Model of Economic Dimensions

Urban places differ in their economic structures and the roles they play within the urban system. The concept of the economic structure of a city is based on the recognition of different economic activities performed by the inhabitants of urban places. These differences lead to recognition of different economic profiles of cities. The emergence of different economic profiles of cities can be traced back to regional variations in the local resource base, changing locational forces affecting an evolution of the regional specialization as well as political factors within the framework of the market economy. The research in this area emphasizes a functional town classification and the identification of the basic latent dimensions of the urban system.

The composition of a city's labor force has traditionally been regarded as the best index of its economic specialization. Different economic profiles of the cities have been most frequently identified from the analysis of employment data. In this thesis this traditional statistical approach will be employed. Also an attempt will be made to determine possible changes in the economic structure (i.e. economic profiles of the cities) of the Canadian urban system thought to be active in differentiating betwen the rates of growth and decline of urban places. Any urban system must have connections between the units of the system. For an urban place to be viable not only must it exchange goods and services with the population of the surrounding area (service area), but also it must exchange goods and services with other urban places of the system; each particular economic function within is contributing towards the whole. These economic dependencies have been made explicit in the concept of a hierarchical system organization in which every city has relations with both higher and lower order centers. From the analysis of such relations one can designate different and distinct levels of order (subsystems) as demonstrated in early works by Christaller and Losch.

As cities increase in size, their economic structures become increasingly complex. Their economy is usually based on a broader mix of activities. Consequently, it is more difficult (if not impossible) to differentiate cities on the basis of one, dominant activity, as in studies by

Christaller and Losch. This multifunctional structure of urban places has been better understood through applications of factor analysis and the concept of urban dimensions. However, since the emphasis here is on the economic characteristics of cities it is better to rename the urban dimensions as economic dimensions. This distinction clarifies the difference between the factorial studies of urban systems based on socio-economic data (i.e. factorial ecology, urban dimensions model) and studies based on economic data only (economic dimensions).

The economic dimensions extracted by means of factor analysis identify the major and distinct regularities within the variables in the data matrix. This enables reduction of the number of variables into a more basic and more easily handled set of variables on the basis of which, the cities can be grouped together by means of their economic dimensions. To determine the economic structure of a city is to know what the position of it is in the urban system. The position of an urban place on the economic dimensions might change through time. The changes can be analyzed by comparing the economic dimensions of cities in different periods of time on a common methodological basis (King, 1966, p.208).

1.8 Objectives and Research Design of the Thesis

The goal of this thesis is partly replicative of past research. However, the original contribution is to test the hypotheses suggested by King, considering the dynamics of the Canadian urban system and changes in its economic dimensions. These hypotheses have been formulated by King on the basis of his cross-sectional analysis of the Canadian urban system in 1951 and 1961. In his study (King, 1966), he pointed out the major features of the Canadian urban system which warrant further attention. These hypotheses will be slightly changed in order to incorporate the model of the economic dimensions mentioned previously (see pp.18-19).

Firstly, there is a question of how the economic dimensions of the Canadian urban system behave over time. In other words, do they remain stable or change through time ? If they remain stable it would suggests a static nature of the urban system. This, however, would contradict much of what is already known about the dynamics of urban systems. Most of the theories on the urban systems which were reviewed in this chapter imply an evolution of the urban system as a whole. The best example of such an approach is the concept of urban concentration or metropolitanization of an urban system over time. It is recognized that most of the economic activities carried on by the urbanized societies, especially in North America, are becoming increasingly concentrated in the major metropolitan areas. As a result there have emerged metropolitan growth poles characterized by very complex organizational forms, sophisticated networks of interdependence and significantly high levels of tertiary employment. Particularly tertiary employment is of great concern in this thesis. The variables measuring the levels of employment in all three major sectors of industry are the core of the data matrices. Therefore, if the Canadian urban system is evolving towards the progressive concentration of economic activities in its major urban centers, the economic dimensions indicating the process of metropolization should yield stronger factor loadings in the factor matrix. In particular, variables indexing tertiary, service, transportation and communication employment should emerge more clearly in the 1981 factor matrix. Also, the overall economic stratification, that is, the number of significant loadings for different sectors of employment should increase in the 1981 as compared to 1971. Moreover, cities located within or near metropolitan areas should have much higher factor scores on the dimensions indicating metropolitanization than the cities located outside these areas.

To summarize, if the Canadian urban system is evolving toward progressive metropolitanization, the following economic dimensions should emerge in the period 1971-81:

1. Concentration of tertiary and service occupations in the major metropolitan centers of Canada.
2. Communication and transportation employment.
3. Progressive stratification of the economic profiles of the cities.
4. Sharper differentiation of the economic dimensions, particularly indexing manufacturing

and service activities between urban centers located within or near metropolitan areas and the rest of Canada.

Secondly, even if the economic dimensions do not change over time significantly, indeed proving the relatively stationary character of the Canadian urban system, the factor scores of individual urban places may vary considerably from one period to another. Therefore, the relative position on the factor score scale will reflect a new economic structure of the cities concerned. In other words, the spatial distribution of the urban places under consideration associated with a particular dimension, may change even if the major economic dimensions remain the same. These two characteristics will be elaborated on after the analysis in subsequent parts of the thesis.

Finally, the objective of the investigation undertaken in this thesis is to describe and examine the Canadian urban system through the analysis of the economic structures of all urban places of over 10,000 inhabitants in Canada. By *examining* the system is meant an analysis of changes in the economic dimensions associated with this system between 1971 and 1981.

To achieve this aim, firstly the sets of demographic, labor force and employment variables in two points of time, 1971 and 1981, will be examined for each urban place by means of the principal-component technique. Secondly, factor loadings extracted from the data matricies will be interpreted in order to determine the basic economic dimensions of the Canadian urban system in 1971 and 1981. Thirdly, a typology of the cities based on their respective factor scores on the economic dimensions will be derived. Finally, the changes in the structure of the Canadian urban system with respect to the economic dimensions of urban places forming this system in the period from 1971 to 1981 will be identified.

1.9 Organization of the Thesis

The objective of this thesis, broadly stated, is to examine the Canadian urban system through the analysis of employment profiles of all Canadian cities having in 1971 and 1981 a population over 10,000 inhabitants.

The first chapter was a review of definitions and concepts relevant to the subject of the urban system, that is dynamics of urban systems, multivariate analysis of urban systems and the model of urban dimensions, as well as a more complete statement of the specific objectives and hypotheses of the thesis. In Chapter Two, description of data and justification of their selection is given. Additionally, the basic units of analysis such as the urban place, census agglomeration and census metropolitan agglomeration will be defined. In Chapter Three, the research methodology by which data are to be analyzed is discussed. The fourth chapter contains an interpretation of the factor loadings and factor scores in order to determine the economic dimensions of the Canadian urban system. The chapter contains also the extracted factor scores which will be plotted on maps for 1971 and 1981. The fifth chapter is an interpretation of the results of the analysis. The interpretation will be based on the detailed examination of changes in the economic dimensions. The results of this examination for 1971 and 1981 are to be compared in order to determine the economic changes in the Canadian urban system. In the final chapter the findings of the thesis will be reviewed, practical and theoretical implications and recommendations will be discussed and conclusions regarding the study and the role of the factor analysis in such urban studies will be made.

II. DATA EVALUATION

The objective of this study is to investigate economic changes in the Canadian urban system over the ten year period 1971-81. The following chapter fulfills two objectives. Firstly, the definition of an urban place and criteria by which variables describing these places were selected, is given. Secondly, there is a detailed description and evaluation of the data selected.

2.1 Definition of Urban Place

A study of an urban system requires a proper definition of an urban place. There are numerous ways in which the urban place can be defined. A particular definition chosen depends on the objective of study and the selection of the variables. With regard to the objective of this thesis the Canadian urban system has been defined as comprising all cities within the political boundaries of Canada. Each city (called also urban place or urban area) is an independent economic entity on its own and defined as a point location within Canada.

There are several spatial units used by the Census of Canada as a basis for data collection. After an examination of these three spatial units have been selected for the purpose of data collection in this thesis.

The first one is a Census Agglomeration (C.A.) which is defined as a city, town or village of at least 1000 population, together with an adjacent built-up area of at least 1000 population and a population density of 1000 persons per square mile (1971, 1981 Census of Canada).

The second spatial unit adopted in this thesis is a Census Agglomeration with population of over 100,000 and subsequently renamed as a Census Metropolitan Area (C.M.A.). The boundaries of C.M.A. were extended to include all urbanized areas (municipalities and incorporated cities) if:

1. The percentage of the labor force in primary activities was less than the national average, and
2. The rate of recent population increase was less than the national average for all C.M.A's

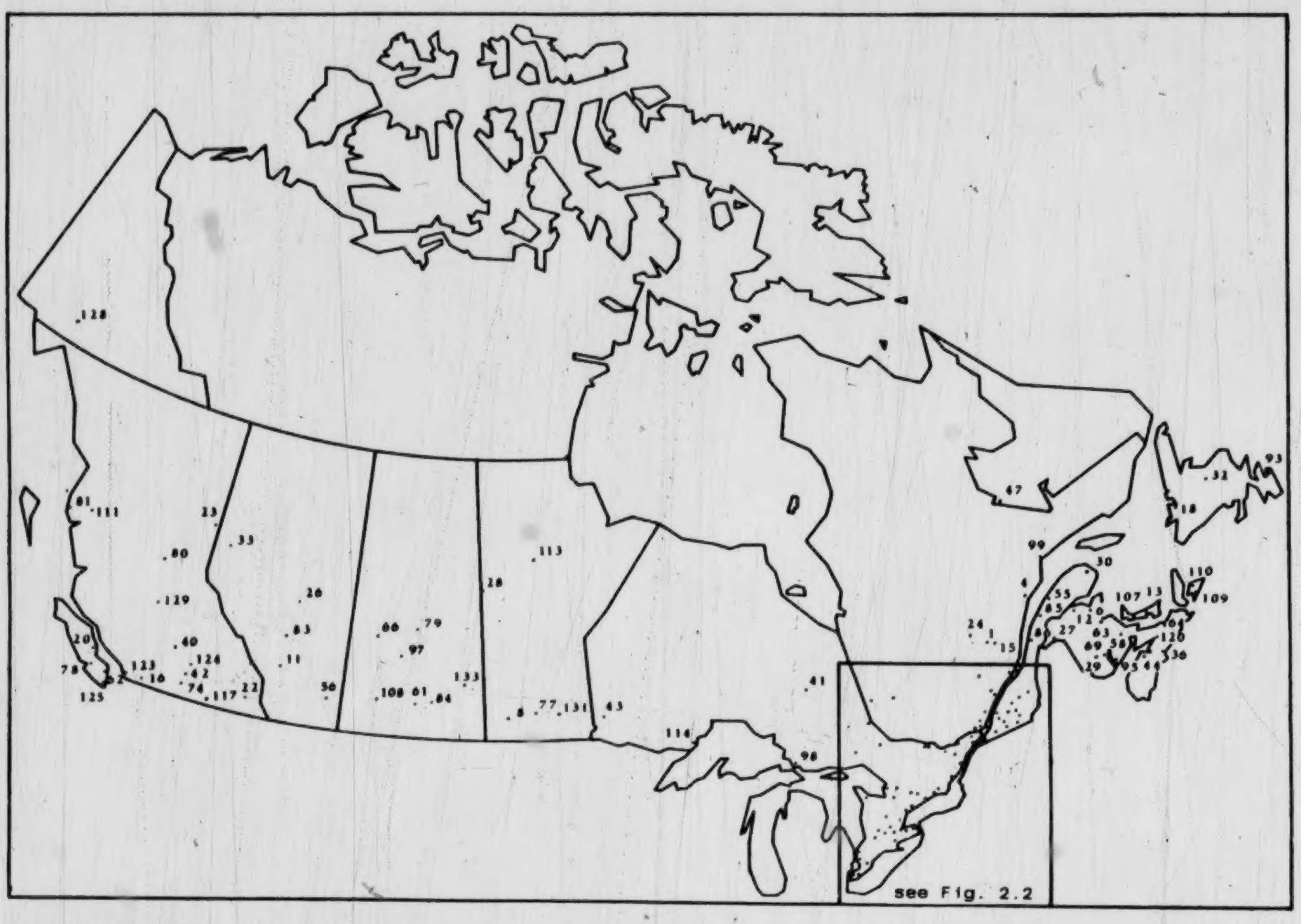
(1971, 1981 Census of Canada).

The third spatial unit chosen is a municipality or incorporated city. The political municipality (city, town or township) is the basic building spatial unit in Canadian urban definitions. However, not all municipalities were used for further aggregation into larger spatial units such as C.M.A's or C.A's by the Census of Canada. Nevertheless, these cities had to be included in this thesis since the scope here is to analyze all urban places in Canada of over 10,000. Consequently, all incorporated cities of more than 10,000 inhabitants not aggregated into larger spatial units in the Census of Canada were included for analysis. A complete list of these cities together with a list of variables in 1971 and 1981 is attached in Appendix 1.

A lower limit of 10,000 inhabitants for an urban place was chosen in order to maintain a consistent definition of a city for both 1971 and 1981. The Census of Canada which is the source of data for this thesis does not provide enough information as to the economic characteristics for cities below 10,000 people. An additional argument for establishing a 10,000 population level criterion is that most urban systems studies were based on an examination of cities of the same population size, therefore allowing for comparability (to a certain extent) of the results.

The exact locations of the cities is given in Figure 2. for 1971 and Figure 3. for 1981. There were 133 cities of over 10,000 people in 1971 (Figure 2.) and 140 cities in 1981 (Figure 3.). Thus, there were only seven more cities in 1981 than in 1971 (Table 3.). Examination of the number of cities by population size indicates that there were two more C.M.A's in 1981 - Oshawa and Trois-Rivieres, than in 1971 (Table 3.). This increase is a result of an areal expansion of municipalities through annexation of surrounding areas rather than by an increase in population within the boundries of 1971.

There are thirteen more C.A's in 1981 than in 1971. It is a relatively significant increase considering the very modest - only two new municipalities - increase in the number of cities of 10,000 to 25,000 population. The increase in the number of C.A's in 1981 is mostly due to the reclassification of some municipalities into a higher category by 1981 Census of Canada.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see Fig. 2.2

Figure 2.1 Urban Places in 1971

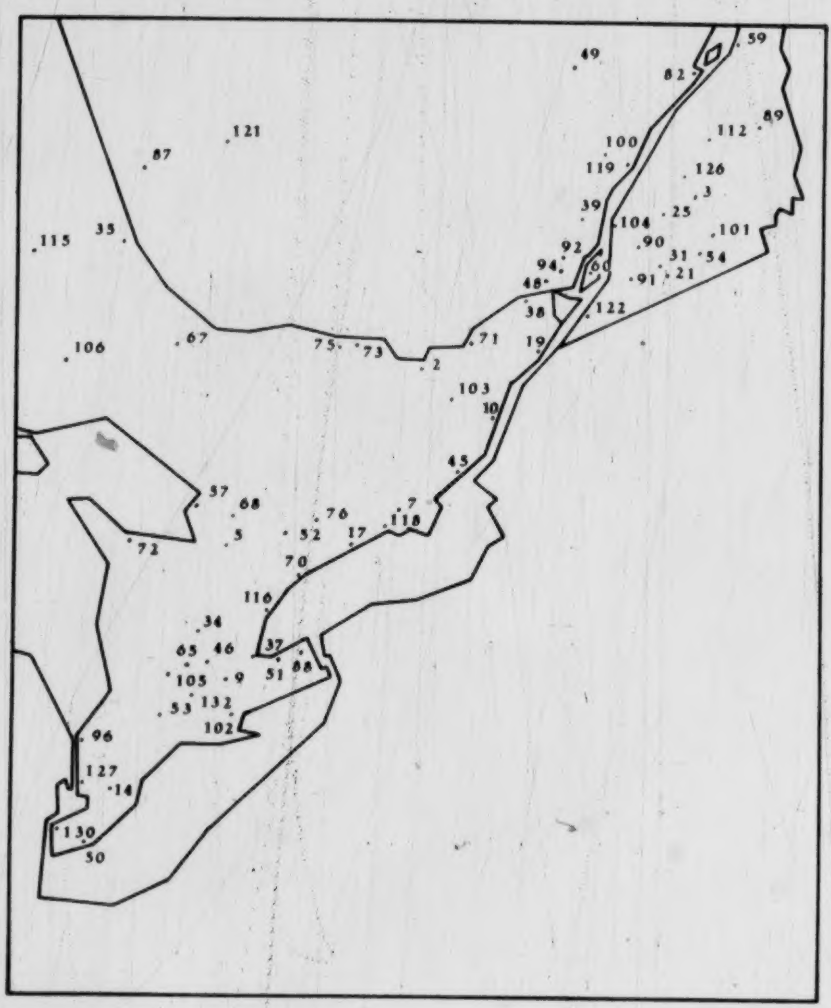
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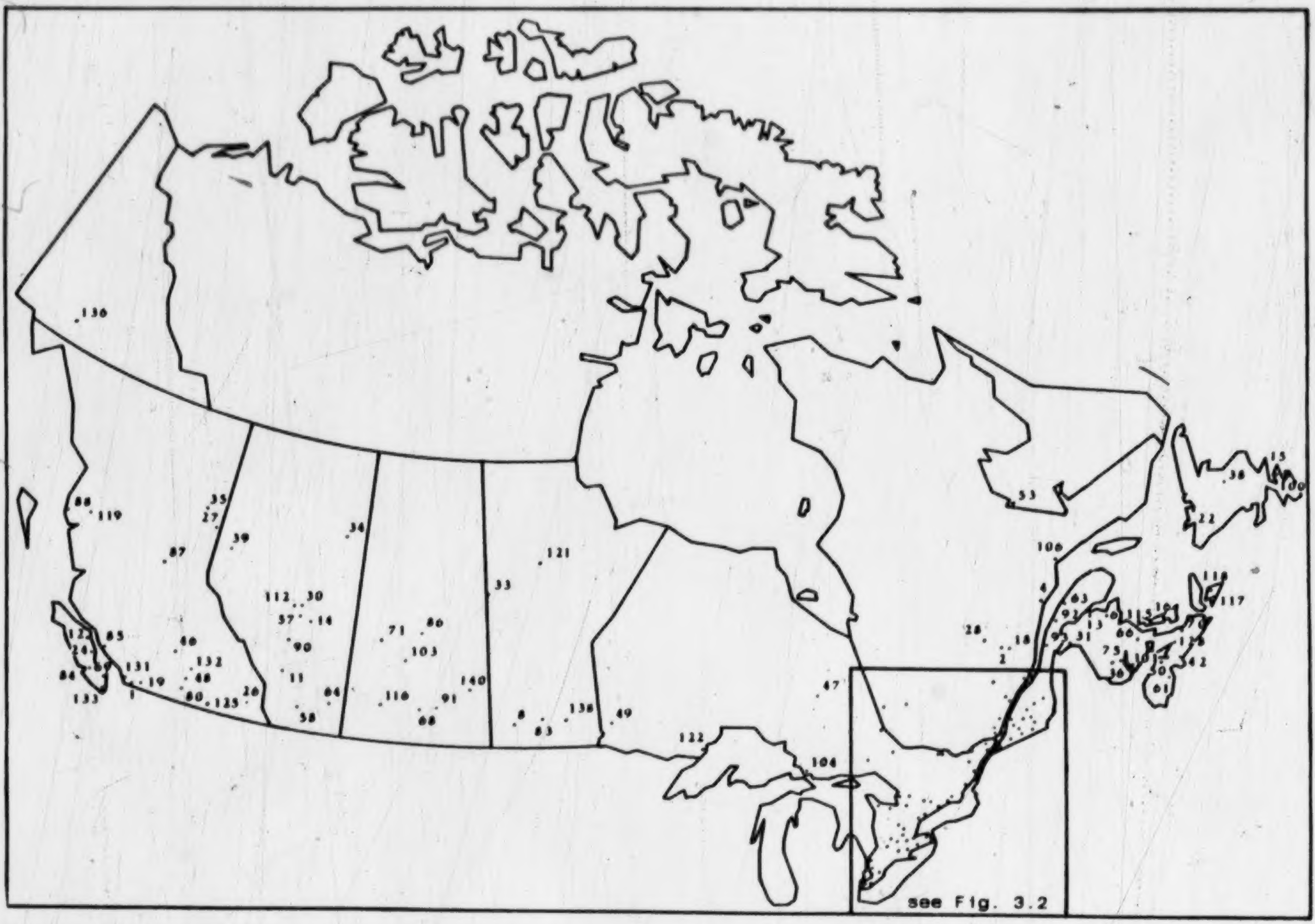
Figure 2.2 Urban Places in 1971 (Continued)

Table 1. List of urban places in 1971

City	Province	City	Province
1. Alma	Q.	68. Orillia	O.
2. Arnprior	O.	69. Oromocto	N.B.
3. Asbestos	Q.	70. Oshawa	O.
4. Baie-Comeau	Q.	71. Ottawa-Hull	O.-Q.
5. Barrie	O.	72. Owen Saund	O.
6. Bathurst	N.B.	73. Pembroke	O.
7. Belleville	O.	74. Penticton	B.C.
8. Brandon	M.	75. Petawawa	O.
9. Brantford	O.	76. Peterborough	O.
10. Brockville	O.	77. Portage la Prairie	M.
11. Calgary	A.	78. Port Alberni	B.C.
12. Campbellton	N.B.	79. Prince Albert	S.
13. Charlottetown	P.E.I.	80. Prince George	B.C.
14. Chatham	O.	81. Prince Rupert	B.C.
15. Chicoutimi-	Q.	82. Quebec	Q.
- Jonquiere	Q.	83. Red Deer	A.
16. Chilliwack	B.C.	84. Regina	S.
17. Cobourg	O.	85. Rimouski	Q.
18. Corner Brook	Nfld.	86. Riviere-du-Loup	Q.
19. Cornwall	O.	87. Rouyn	Q.
20. Courtenay	B.C.	88. St.Catharines-	
21. Cowansville	Q.	-Niagara	O.
22. Cranbrook	B.C.	89. St.Georges	Q.
23. Dawson Creek	B.C.	90. St.Hyacinthe	Q.
24. Dolbeau	Q.	91. St.Jean	Q.
25. Drummondville	Q.	92. St.Jerome	Q.
26. Edmonton	A.	93. St.John's	Nfld.
27. Edmundston	N.B.	94. Ste.Scholastique	Q.
28. Flin-Flon	M.-S.	95. Saint John	N.B.
29. Fredericton	N.B.	96. Sarnia	O.
30. Gaspe	Q.	97. Saskatoon	S.
31. Granby	Q.	98. Sault Ste.Marie	O.
32. Grand Falls	Nfld.	99. Sept-Iles	Q.
33. Grande Prairie	A.	100. Shawinigan	Q.
34. Guelph	O.	101. Sherbrooke	Q.
35. Haileybury	O.	102. Simcoe	O.
36. Halifax	N.S.	103. Smiths Falls	O.
37. Hamilton	O.	104. Sorel	Q.
38. Hawkesbury	O.-Q.	105. Stratford	O.
39. Joliette	Q.	106. Sudbury	O.
40. Kamloops	B.C.	107. Summerside	P.E.I.
41. Kapuskasing	O.	108. Swift Current	S.
42. Kelowna	B.C.	109. Sydney	N.S.
43. Kenora	O.	110. Sydney Mines	N.S.
44. Kentville	N.S.	111. Terrace	B.C.
45. Kingston	O.	112. Thetford Mines	Q.
46. Kitchener	O.	113. Thompson	M.
47. Labrador City	Nfld.	114. Thunder Bay	O.
48. Lachute	Q.	115. Timmins	O.
49. La Tuque	Q.	116. Toronto	O.
50. Leamington	O.	117. Trail	B.C.
51. Lincoln	O.	118. Trenton	O.
52. Lindsay	O.	119. Trois-Rivieres	Q.
53. London	O.	120. Truro	N.S.
54. Magog	Q.	121. Val d'Or	Q.
55. Matane	Q.	122. Valleyfield	B.C.
56. Medicine Hat	A.	123. Vancouver	B.C.
57. Midland	O.	124. Vernon	B.C.
58. Moncton	N.B.	125. Victoria	B.C.
59. Montmagny	Q.	126. Victoriaville	Q.
60. Montreal	Q.	127. Wallaceburg	O.
61. Moose Jaw	S.	128. Whitehorse	Y.
62. Nanaimo	B.C.	129. Williams Lake	B.C.
63. Newcastle	N.B.	130. Windsor	O.
64. New Glasgow	N.S.	131. Winnipeg	M.
65. New Hamburg	O.	132. Woodstock	O.
66. North Battleford	S.	133. Yorkton	S.
67. North Bay	O.		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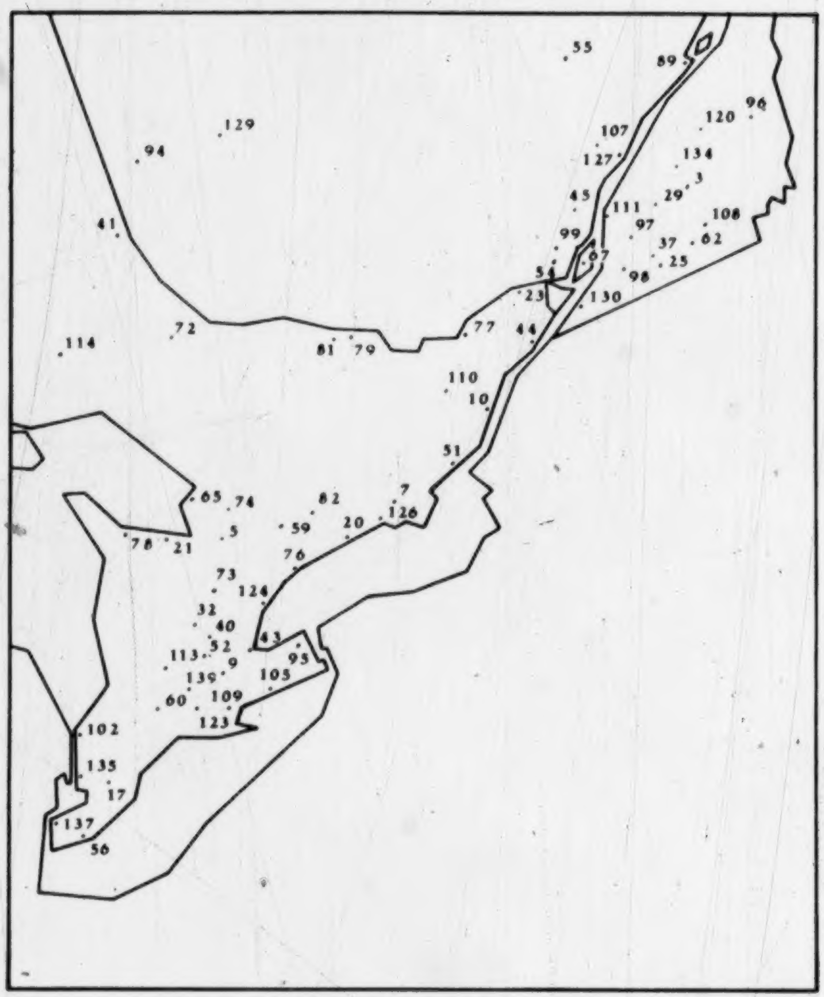
24
85
131
19
84
133
1
60
132
48
80
125
26
28
18
2
106
4
63
93
13
31
60
73
61
53
38
15
22
117
see Fig. 3.2

Figure 3.1 Urban Places in 1981


55
89
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107
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139
105
109
60
123
102
135
17
137
56

Figure 3.2 Urban Places in 1981 (Continued)

Table 2. List of urban places in 1981

City	Province
1. Abbotsford	B.C.
2. Alma	Q.
3. Asbestos	Q.
4. Baie-Comeau	Q.
5. Barrie	O.
6. Bathurst	N.B.
7. Belleville	O.
8. Brandon	M.
9. Brantford	O.
10. Brockville	O.
11. Calgary	A.
12. Campbell River	B.C.
13. Campbellton	N.B.
14. Camrose	A.
15. Carbonear	Nfld.
16. Charlottetown	P.E.I.
17. Chatham	O.
18. Chicoutimi- - Jonquiere	Q. Q.
19. Chilliwack	B.C.
20. Cobourg	O.
21. Collingwood	O.
22. Corner Brook	Nfld.
23. Cornwall	O.
24. Courtenay	B.C.
25. Cowansville	Q.
26. Cranbrook	B.C.
27. Dawson Creek	B.C.
28. Dolbeau	Q.
29. Drummondville	Q.
30. Edmonton	A.
31. Edmundston	N.B.
32. Fergus	O.
33. Flin-Flon	M.-S.
34. Fort McMurray	A.
35. Fort St.John	B.C.
36. Fredericton	N.B.
37. Granby	Q.
38. Grand Falls	Nfld.
39. Grande Prairie	A.
40. Guelph	O.
41. Haileybury	O.
42. Halifax	N.S.
43. Hamilton	O.
44. Hawkesbury	O.-Q.
45. Joliette	Q.
46. Kamloops	B.C.
47. Kapuskasing	O.
48. Kelowna	B.C.
49. Kenora	O.
50. Kentville	N.S.
51. Kingston	O.
52. Kitchener	O.
53. Labrador City	Nfld.
54. Lachute	Q.
55. La Tuque	Q.
56. Leamington	O.
57. Leduc	A.
58. Lethbridge	A.
59. Lindsay	O.
60. London	O.
61. Lunenburg	N.S.
62. Magog	Q.
63. Matane	Q.
64. Medicine Hat	A.
65. Midland	O.
66. Moncton	N.B.
67. Montreal	Q.
68. Moose Jaw	S.
69. Nanaimo	B.C.
70. New Glasgow	N.S.
71. North Battleford	S.
72. North Bay	O.
73. Orangeville	O.
74. Orillia	O.
75. Oromocto	N.B.
76. Oshawa	O.
77. Ottawa-Hull	O.-Q.
78. Owen Sound	O.
79. Pembroke	O.
80. Penticton	B.C.
81. Petawawa	O.
82. Peterborough	O.
83. Portage la Prairie	M.
84. Port Alberni	B.C.
85. Powell River	B.C.
86. Prince Albert	S.
87. Prince George	B.C.
88. Prince Rupert	B.C.
89. Quebec	Q.
90. Red Deer	A.
91. Regina	S.
92. Rimouski	Q.
93. Riviere-du-Loup	Q.
94. Rouyn	Q.
95. St.Catharines- -Niagara	O.
96. St.Georges	Q.
97. St.Hyacinthe	Q.
98. St.Jean	Q.
99. St.Jerome	Q.
100. St.John's	Nfld.
101. Saint John	N.B.
102. Sarnia	O.
103. Saskatoon	S.
104. Sault Ste.Marie	O.
105. Selkirk	O.
106. Sept-Iles	Q.
107. Shawinigan	Q.
108. Sherbrooke	Q.
109. Simcoe	O.
110. Smiths Falls	O.
111. Sorel	Q.
112. Spruce Grove	A.
113. Stratford	O.
114. Sudbury	O.
115. Summerside	P.E.I.
116. Swift Current	S.
117. Sydney	N.S.
118. Sydney Mines	N.S.
119. Terrace	B.C.
120. Thetford Mines	Q.
121. Thompson	M.
122. Thunder Bay	O.
123. Tillsonburg	O.
124. Toronto	O.
125. Trail	B.C.
126. Trenton	O.
127. Trois-Rivieres	Q.
128. Truro	N.S.
129. Val d'Or	Q.
130. Valleyfield	B.C.
131. Vancouver	B.C.
132. Vernon	B.C.
133. Victoria	B.C.
134. Victoriaville	Q.
135. Wallaceburg	O.
136. Whitehorse	Y.
137. Windsor	O.
138. Winnipeg	M.
139. Woodstock	O.
140. Yorkton	S.

Table 3. Canadian Cities by Population Size: 1971-1981

Year	above 1,000,000		1,000,000-100,000		100,000-50,000		50,000-25,000		25,000-10,000		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	No.
1971	3	2.2	19	14.3	11	14.3	37	27.8	63	47.4	133
1981	3	2.1	21	15.0	21	12.9	41	29.3	57	40.7	140
Change	0	-0.1	2	0.7	10	-1.4	4	1.5	-6	-6.7	7

There were three cities of over 1,000,000 people (Table 3.), both in 1971 and 1981. However, in the class of 100,000 to 1,000,000 there were two more cities in 1981 than in 1971. There were also ten more cities in 1981 of the 50,000 to 100,000 size and four more cities of the size 25,000 to 50,000. Of the number of small urban centers in 1971 and 1981 there were six fewer cities of 10,000 to 25,000 inhabitants in 1981 than 1971. This decline may be due to several socio-economic factors, such as a decreasing rate of population growth, out-migration, unemployment and a shift in industrial activity. The mean of the population change ratio (Table 5.) for all cities in Canada in 1971 was 7.4 and this decreased to 5.0 in 1981. The ratio (the definition is given in the next paragraph) indicates a trend in the Canadian urban system towards a declining growth rate of the system as a whole. In both points of time, the ratio of population change was less than the nation as a whole. The examination of the number of cities by their population size reflects declining growth of the small cities in Canada.

The variation of population growth rate as measured by the standard deviation (Table 5.) also indicates a slow-down in the evolution of the Canadian urban system. The standard deviation of the population change ratio in 1971 was 10.7, while it was 7.2 in 1981. The ratio of population change reflects the declining population growth rate of the Canadian cities. The entire distribution of population growth shifts downward, meaning that some cities were declining in population in the ten year period 1971-1981. There were twenty-five cities in 1971 with a negative value of population change of which nine declined in size below the level of 10,000 and consequently were not included in further analysis for 1981. However, in 1981 there were twenty-eight cities with a negative value of population change (see Table 4. for definition of the population change ratio).

No single explanation can account for all these changes. The most rapid declines in the population growth were recorded for the resource based cities such as Asbestos, Timmins, Sydney or Val d'Or, which suffered from the fluctuations in demand for raw materials and precious metals on the international market. For example, the price of gold declined affecting the gold-mining industry at Val d'Or. The domination of a single industry, especially primary industry, in their economic structure will emerge from the principal-component analysis, since the relatively simple employment structure of these cities is very sensitive to economic fluctuations. An attempt to examine this phenomenon more closely will be made in subsequent sections of the thesis.

2.2 Selection of Variables. Demographic and Labor Force Data

Since the focus in this thesis is on the economic changes of the Canadian urban system, the cities comprising this system will be analyzed by means of numbers of workers employed in various industries as defined by the Standard Occupation Classification Manual (Statistics Canada, 1970). All variables were collected from 1971 and 1981 Census of Canada. A complete list of sources is attached in the references and the sources section of the thesis.

The employment data was supplemented by selected demographic and labor force variables to provide an additional source of information as to the causes of economic change within the Canadian urban system. This data is generally considered a significant indicator of economic magnitude with which planners and policymakers must be concerned. Another broadly used unit of measurment in urban and regional analysis is income or total payroll variables. Isard wrote:

> "Clearly, deeper insight into the character of an area's economic support can be obtained when employment data are supplemented by income data."(Isard, 1960, p.195).

However, there are several significant drawbacks to income as a unit of measurement. For example, it is hard to find an index of income that accurately measures the price of labor on which income data are based because it varies widely in context and in forms of payment. Again, as Isard pointed out, the major drawback of income data:

> "...is their failure to indicate either precisely or crudely the influence of ***unearned*** income (primarily property income and income payments from government agencies)..."(Isard, 1960, p.194).

Moreover, the welfare of the wage-earners depends not on how much money income he/she receives, but on real income, which depends on commodity prices. An increase in money income may or may not mean an equal increase in real income, depending on the relative movements of prices and money (payroll) wages.

> "In reality, calculating the real well-being of workers requires an accurate measure of the prices of goods and services purchased by wage-earners. However, accurate measures of these prices are not available."(Ostry & Zaidi, 1972, p.205).

In other words, changes in income are not necessarily a reflection of any economic change. Moreover, a thorough and comprehensive examination of all the aspects of income for any country or industry, including Canada, is a task of enormous magnitude, far beyond the scope of this thesis. For both of these reasons, income data were not included in the research design of this thesis. As a result, data matrices in the thesis for 1971 and 1981 are comprised of three groups: Demographic Variables, Labor Force Variables and Employment Variables (Table 4.).

The demographic data comprise two variables i.e. total population of an urban place (POP1) and the population change ratio (CH2), expressed as a difference between 1971 and 1961 total population of an urban place divided by its population in 1961; and a difference between 1981 and 1971 total population divided by 1971 population.

There is not enough evidence that there is any direct relation between population size of a city and its economic growth. However, it has been shown that with increasing population size the diversity of economic activities carried on in a city increases as well. Thompson, for example, has suggested (Thompson, 1965, pp.21-24) that there is an ***urban ratchet*** effect which persists once a city attains a particular population threshold size and which stimulates a steady economic growth thereby. The second demographic variable, i.e. population change ratio, indicates a diversification between declining and growing urban centers, since there were numerous cities both in 1971 and 1981 with a negative ratio of population change. This subject will be discussed in more detail in the next section of this chapter.

Table 4. List of Variables

Code	Variable name	Description
		DEMOGRAPHIC VARIABLES
POP1	Total population	Total number of inhabitants of a city in 1971 or 1981.
CH2	Population change ratio	It is the ratio of the difference between 1961 and 1971(or 1971 and 1981) total populations of a city.
		LABOR FORCE VARIABLES
M4	Male participation rate	A percentage of the total male labor force of 15 years of age and over, excluding inmates, in an area, group or category.
M5	Male unemployment rate	A percentage ot those males in the labor force who were without work, actively looked for work and were available for work.
F9	Female participation rate	A percentage of the total female labor force of 15 years of age and over, excluding inmates, in an area, group or category.
F10	Female unemployment rate	A percentage of those females in the labor force who were without work, actively looked for work and were available for work.
		EMPLOYMENT VARIABLES
R14	Male to female ratio	The total number of males in the labor force per total number of females in the labor force.
R15	Managerial, administrative and related occupations	The number of persons employed in managerial, administrative and related occupations.
R16	Occupations in natural sciences	The number of persons employed in natural sciences, engineering and mathematics.
R17	Occupations in social sciences	The number of persons employed in social sciences, services and related fields (eg. psychology, sociology, history etc.)
R18	Occupations in religious services	The number of persons employed in religious services.
R19	Occupations in teaching	The number of persons employed in elementary, secondary schools and related occupations.
R20	Occupations in medicine and health	The number of persons employed in health diagnosing, treating occupations, nursing, therapy and related occupations.
R21	Artistic, literary and recreational occupations	The number of persons employed in artistic, literary, recreational and related occupations.
R22	Clerical and related occupations	The number of persons employed in clerical and related occupations.

Table 4. List of Variables (Continued)

Code	Variable name	Description
R23	Sales occupations	The number of persons employed as salesmans, salespersons, sales clerks and related occupations.
R24	Service occupations	The number of persons employed in service occupations.
R25	Primary employment	The number of persons employed in agriculture, foresting, fishing, trapping and mining occupations.
R26	Processing occupations	The number of persons employed in metal, wood, textile and baverage processing and related processing occupations.
R27	Machinery occupations	The number of persons employed in metal machining, metal shaping, forming, welding, flqme cutting and related occupations.
R28	Product fabricating occupations	The number of persons employed in product fabricating, assembling, reparing and related occupations.
R29	Construction occupations	The number of persons employed in construction and related occupations.
R30	Transport equipment operating occupations	The number of persons employed in transport equipment operating occupations.
R31	Material handling occupations	The number of persons employed in material handling and related occupations.
R32	Other crafts occupations	The number of persons employed in printing, stationary engine, utilities equipment and related occupations.
R33	Secondary employment	The number of persons employed in manufacturing and construction occupations. The sum of variables from R26 to R32.
R34	Tertiary employment	The number of persons employed in retail, wholesale trade, service occupations. The sum of variables from R15 to R24.

The second group of variables,the labor force variables, consists of variables: participation rates of male and female labor force (M5 and F9). The labor force participation rate:

> "...refers to the percentage of the total labor force (...) forms of the total population 15 years of age and over, excluding inmates, in an area, group or category."(1981 Census of Canada, Cat.95-945, p.XVI).

The unemployment rate:

> "...refers to the percentage of those persons in the labor force who were without work, actively looking for work and were available for work."(1981 Census of Canada, Cat.95-945, p.XVI).

The participation rates in 1971 and 1981 indicate changes in the labor force activity for urban areas within the Canadian urban system. The male and female participation rates, together with their respective unemployment rates, will provide a basis for an examination of relation between economic change within the urban system and shifts in the male/ female employment levels. For example, the relatively low female participation ratio in 1971 - 39.0% shifted upward to the much higher one in 1981 - 51.0%, indicating a changing orientation of the traditionally male dominated labor force on the Canadian labor market. However, the spatial distribution of the female participation rate varied in 1971 from 25.9% in St.Scholastique to 54.5% in Whitehorse. Therefore, it can be anticipated that there is a certain relationship between these characteristics and the growth performance of any city between 1971 and 1981. The existing literature is inconclusive as to the direction and strength of this relationship. However, Duncan and Reiss found (Duncan & Reiss, 1956, pp.183-211) that rapidly growing cities had higher percentages of persons in white-collar tertiary occupations and were characterized by a high female participation rate. Consequently, it can be expected that cities with higher female participation rates will be characterized by higher growth rates.

The labor force variables provide an important source of information as to the relationship between the unemployment levels and employment structure of a city. Particular attention will be given to the correlation between the unemployment rates, which varies from a minimum 2.6% in Labrador City to 27.6% in Flin Flon for males and a minimum 5.7% in Arnprior to 18.7% in Alma for females in 1971 (Table 5.) and the employment structures of the Canadian cities. This relationship has not been satisfactorily explained in the geographic literature. It is particularly difficult to ascertain whether certain types of industry that dominate an urban economic structure influence directly the unemployment rate. It was shown by Ostry and Zaidi (1972, pp.135-139) that the industry in which a worker is employed also influences his risk of joblessness:

> "...longer-run structural changes in patterns of consumer demand, in technology, and in resource allocation may raise the unemployment risk in particular industries, although these patterns cannot be established by a priori reasoning." (Ostry & Zaidi, 1972, p.137).

Notwithstanding, the relation exists and has to be taken into account in a study of the Canadian urban system.

The last group, the employment variables, will be considered separately since they provide the core data for the thesis.

2.3 Employment Variables

The choice of the input data to be included in the principal-component analysis is a critical step. The nature and relative importance of factor loadings extracted from the analysis are directly dependent on the initial data set. Therefore, the proper selection of occupational classes of the employment data is one of the most important conditions of the analysis. Employment in industries by occupations in the economic profiles of cities represented by the Standard Occupation Classification adopted in this thesis differs considerably both in size and in distributional variability. Since the method used in this thesis demands identification of a state of affairs taken to represent complete or approximately complete diversification, all major occupations comprising the employment structure have to be taken into account. As a result,

Table 5. The Basic Statistics

	1971				1981			
Code	Mean	Std.Dev.	Min.	Max.	Mean	Std.Dev.	Min.	Max.
R22	113,001	349,093	10,010	2,743,208	125,432	374,436	9,897	2,998,947
CH2	7.4	10.6	-19.0	52.9	5.2	7.2	-17.3	34.1
M4	75.8	6.0	63.4	95.0	78.0	4.8	66.5	92.4
M5	8.4	3.4	2.6	27.6	7.4	4.0	1.9	29.2
F9	39.0	5.7	25.9	54.5	51.0	6.2	36.1	72.0
F10	10.4	2.9	5.7	18.7	10.9	4.5	3.3	32.8
R14	2.1	1.1	1.4	10.8	1.5	0.2	1.2	2.6
R15	3.6	1.0	1.0	8.2	7.6	1.8	3.3	13.0
R16	2.3	1.1	0.6	5.9	2.8	1.2	1.1	7.5
R17	1.0	0.6	0.1	5.2	1.6	1.0	0.4	7.6
R18	0.3	0.3	0.1	2.2	0.3	0.2	0.0	1.0
R19	4.6	1.2	2.0	9.6	4.4	1.1	2.1	7.5
R20	4.6	1.9	1.5	11.0	5.1	1.6	2.2	12.7
R21	1.5	1.4	0.03	7.2	1.2	0.9	0.5	11.1
R22	14.3	3.0	7.9	24.7	17.0	3.0	2.7	26.3
R23	10.2	2.0	3.9	14.7	9.3	1.8	4.4	19.2
R24	13.4	7.0	7.0	69.5	13.6	4.9	8.0	48.0
R25	4.3	4.1	0.6	24.4	4.6	3.8	0.7	19.1
R26	5.3	3.7	0.0	19.4	5.4	3.9	0.3	17.8
R27	5.5	4.0	0.0	22.3	2.7	1.7	0.6	11.7
R28	6.6	3.3	0.6	17.2	8.1	3.3	0.3	18.8
R29	6.8	1.7	1.5	11.8	7.2	2.1	3.4	14.6
R30	4.0	1.3	0.7	9.1	4.1	1.1	2.1	7.7
R31	3.0	1.2	0.1	8.4	2.1	0.8	0.7	5.1
R32	3.3	2.1	0.2	9.1	1.3	1.2	0.4	14.4
R33	34.5	8.2	3.2	56.3	30.8	6.4	15.4	48.6
R34	57.9	8.8	31.0	90.4	64.4	7.8	39.6	82.0

For explanation of the variable codes see Table 4.

twenty-two major occupational sectors have been selected for further analysis. These are listed in Table 4.

The employment data has been obtained from 1971 and 1981 Census of Canada. The use of occupational employment data, rather than industrial employment data is justified on the basis that they reflect more accurately the job structure in the labor force of Canadian cities. The industrial employment data are based on the classification of workers by industry. Therefore, clerks employed in the administration of a mine are classified as miners not as clerks. The use of such data in the thesis would lead to misleading conclusions.

The Standard Occupation Classification (Statistics Canada, 1970) has been adopted in the thesis for two reasons. Firstly, the occupational classification defined by the Census of Canada, although far from being perfect, is the only suitable data base for the study of the urban system on a national scale. Initially it was intended to use more detailed data. Unfortunately these statistics, particularly for smaller urban centers (cities of less than 25,000 population in 1971), were not directly available from the Census of Canada. The financial constraints of this research have restricted the number of variables that initially it was the intention to examine. Secondly, the occupational classification is defined for 1971 and 1981 Census of Canada on the same basis. Therefore, the results of the analysis for 1971 and 1981 can be compared directly.

The employment data have been grouped into three major sectors of industry which were defined as follows:

1. Primary sector: employment which includes agriculture, forestry, hunting, fishing and extractive industries like mining and quarrying. All these occupations were aggregated to form the variable R25.
2. Secondary sector: employment which includes manufacturing, production of electric power and gas and construction industries; variables from R26 to R32 were summed to form the variable R33.
3. Tertiary sector: employment which includes commerce, transport and services of all kinds;

variables from R15 to R24 were aggregated to form the variable R34.

The major purpose of this grouping is that the employment data aggregated in this way is easier to handle and examine, particularly in a study concerned with all cities in Canada. The major statistical characteristics of the employment variables are listed in Table 5. They include means of the total population of each variable, standard deviations of each variable and the range of each variable.

Examination of these statistics reveals that the major share of the total employment was in clerical and related occupations (R22) in 1971 as well as in 1981. However, the analysis of the employment by sectors indicates a shift in the distribution from 57.9% in the tertiary sector in 1971 to 64.4% in this sector in 1981 for the entire population of all the cities. This shift might suggest a tendency towards increasing concentration of economic activities within or near major metropolitan areas in Canada.

The variation in the distribution of the tertiary employment, as measured by one standard deviation, reveals that there were more cities falling into the group above the standard deviation in 1981 than in 1971. For example, cities like Fredericton, Halifax, Kingston and Ottawa-Hull were the only large cities above one standard deviation employment (8.8) in the tertiary sector in 1971 (Table 5). In 1981 these cities retained their high shares of the tertiary employment and the group was enlarged by Quebec-City, Regina, St.John's and Victoria.

The cities with the largest share of the tertiary employment in 1971 were Oromocto - 90.4% and Petawawa - 78.4%. The lowest employment in this sector was recorded in St.Scholastique - 31.0%. In 1981 Sarnia had the lowest tertiary employment - 39.6%, while Ottawa-Hull was at the other extreme of the scale with 82.0% of employment in this sector. The cities with below one standard deviation tertiary employment in 1971 were mostly mining and manufacturing centers of Ontario and Quebec, such as Arnprior, Asbestos, Baie-Comeau and Sudbury. The standard deviation indicates cities with significantly different levels of tertiary employment from the rest of the population of the Canadian cities. To this group belonged also mining towns of the Prairie Provinces and small cities of British Columbia depending on forestry industries eg. Flin-Flon, Brandon, Powell River, Prince Rupert and Trail. This distribution was retained throughout the ten years under study. In 1981 most of the cities with less than one standard deviation employment in the tertiary sector were located in Southern Ontario and Quebec.

The opposite distribution can be noted for secondary employment. Cities with above one standard deviation employment in the tertiary sector had below standard deviation employment in the secondary sector both in 1971 and 1981, eg. Fredericton, Halifax, Ottawa-Hull, Quebec-City and Regina. Also cities of Western Canada and the Maritime Provinces were characterized by this type of economic profile, eg. Calgary, Charlottetown, Chilliwack, Edmonton, Red Deer and Victoria. Therefore, it can be expected that a negative correlation between tertiary and secondary sectors will emerge on one of the economic dimensions in the fuller analysis. The city with the highest secondary employment in 1971 was Arnprior - 56.3% and in 1981 Terrace - 48.6%. The lowest secondary employment was in Oromocto, only 3.8% due to extremely high service employment in the military sector. In 1981 the lowest share of employment in this sector was in Ottawa-Hull - 15.4%.

Yet, the standard deviations in secondary and tertiary employment reveal a more even distribution in 1981 than 1971 for these sectors among all Canadian cities. The standard deviation of 8.2 in the secondary sector and 8.8 in the tertiary sector in 1971 indicates a relatively high variation in the distribution of employment, as indeed is indicated by the minimum and maximum values of the respective sectors (Table 5.). The same change occurred in the primary sector of industry which in 1971 had a standard deviation 4.1 and 3.8 in 1981. The cities above one standard deviation in primary employment both in 1971 and 1981 were for the most part the mining centers of Quebec - Asbestos, Lachute, Val d'Or; Ontario - Sudbury, Tillsonburg and the Maritime Provincies - Kentville, Labrador City and Lunenburg. In this group were also cities depending to a large degree on the oil industry - Calgary - and forestry - Port Alberni, Powell River. The cities with the largest employment in primary industry in 1971 were Lincoln 21.4% and Thompson 19.5%, while in 1981 they were Lachute - 19.1% and

Labrador City - 16.2%. Most of the cities with a significant share of primary employment in their economic profiles were below one standard deviation in the tertiary sector eg. Asbestos, Flin-Flon, Labrador City, Lachute.

The frequency distribution of towns by the percentage of employed in the primary industry in 1971 and 1981 implies that the general pattern was retained throughout the ten year period. Therefore, it can be expected that this sector will not contribute significantly to the economic dimensions solution in the factor analysis.

The employment data were subsequently aggregated together with the demographic and labor force variables into two matrices; 27 variables by 133 cities in 1971 and 27 variables by 140 cities in 1981. These data matrices will be used for further transformation into cross-sectional correlations of the variables by means of the principal-component technique described in detail in the next chapter.

III. METHOD OF THE THESIS

Factor analysis has become a basic research tool in many contemporary studies in urban geography. Considering the relatively underdeveloped theory in the field of quantitative urban systems analysis, the principal-component technique has been adopted in many of these studies as the best means for examining urban systems quantitatively. The most relevant applications of factor analysis in urban systems research were reviewed in the first chapter of the thesis.

The principal-component method was applied in this thesis in order to examine possible economic changes in the Canadian urban system. This technique provides a unique opportunity to examine the complex interrelations of the factors which play a part in the differentiation of the economic growth and decline of the urban places forming the Canadian urban system. The technique enables the handling of large sets of data which characterize the urban system on a national level, reducing the number of relevant variables, and at least theoretically, providing directions for further research. Finally, by reducing the amount of redundant information within the data matrix, the technique exposes those interrelations between the variables which would be otherwise overlooked.

Among the many variants of factor analysis (eg. Alpha, Maximum Likelihood, Image Factor Analysis, etc.) the principal-component technique has been used most frequently. The mathematical foundations of this method were created by H.Hotelling (1933). The relative simplicity as compared to other factor analysis techniques and the verified mathematical model contributed to the popularity of this technique. The essence of the principal-component method is a transformation of the initial *k* variables, characterizing *n* cities into a reduced set of new variables, *F*, called principal components or factors. The statistical algorithm of the technique applied in this thesis can be expressed as:

$$zk = f \times F + f \times F + \ldots + f \times F$$

where zk - standardized variables (1,2,...,k)

F ;F ;...;F - factor loadings (m - factors, k - variables)

The research-design of the thesis is shown in Figure 4. It comprises three major stages: preparation, factor analysis and interpretation of results. The first one, preparation, consists of the formulation of the problem, the choice of the principal-component technique and selection of the variables. Since the objective of this thesis is to analyze changes in the Canadian urban system at two points in time, 1971 and 1981, two data matrices were generated. The first one, *A1*, for 1971 contains 133 cases (cities) by 27 variables, while the second one, *A2*, for 1981 contains 140 cases by the same number of variables. These matrices were the data basis for further transformations by means of the principal-component analysis performed separately for 1971 and 1981. The detailed description of the factor analysis stage of the research procedure is attached in Appendix 2.

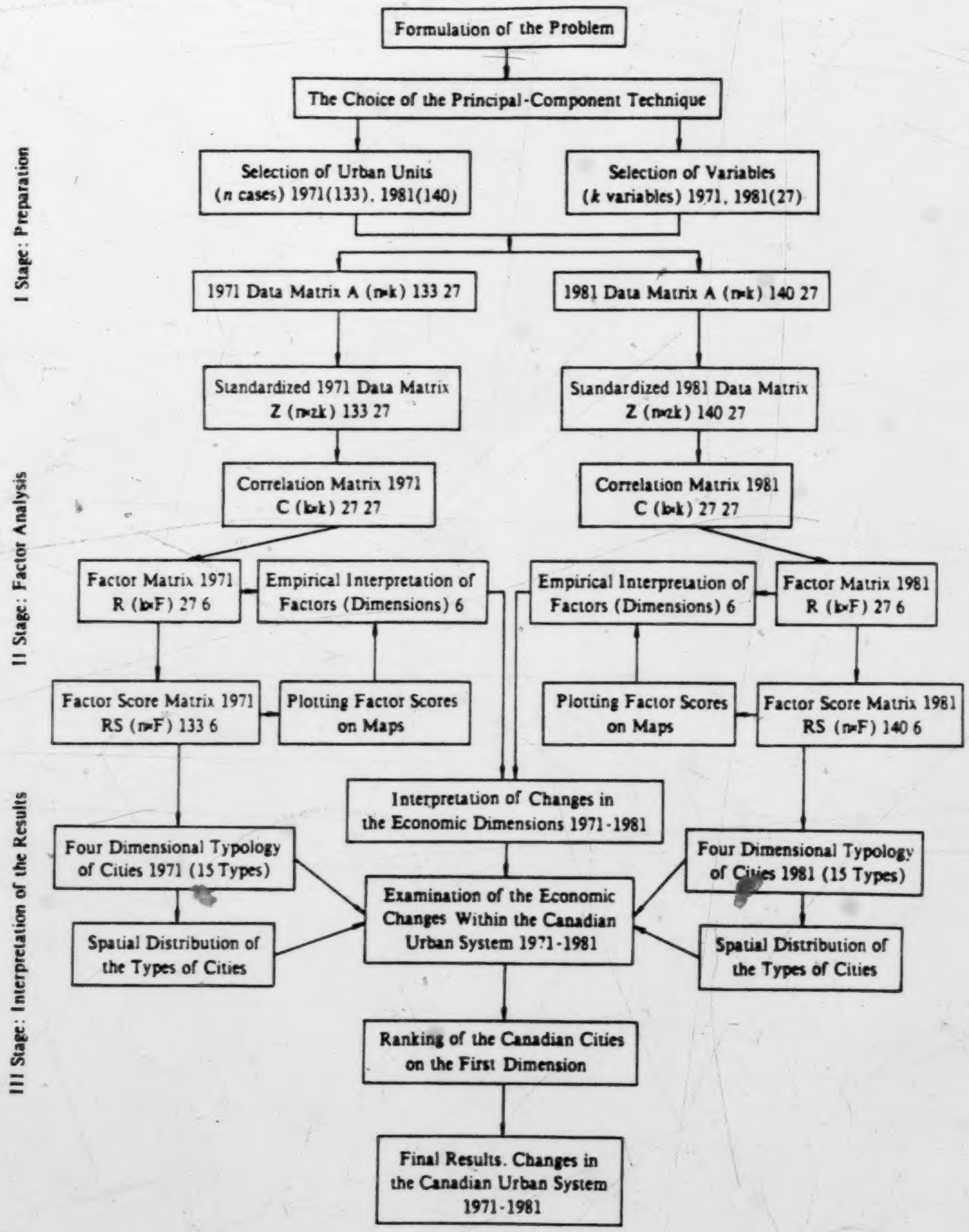
3.1 Interpretation of the Factor Loadings

The interpretation of the factors, *F*, is based on the factor loadings which express correlation of variables, *k*, with each dimension (Figure 4.). Each of the factors is explained in terms of the variables, *k*, which have the highest loadings, *f*, on them. Hence, the interpretation is called empirical since the subsequent names of the factors which are, so far, only mathematical artifacts, express the associations of the factors with variables, *k*, in the data matrix, *A*.

The factor loadings may vary from 1.0 which is a perfect correlation to 0, no correlation. The positive factor loadings express a positive correlation, while the negative factor loadings, the opposite. There is no clear agreement as to the significance of the factor loadings. In most of the existing factorial studies a level +0.5 is considered to be a high factor loading and +0.7, a very high factor loading (Yeates, 1974, p.225). Therefore, these levels will be applied in this thesis.

The factor matrix reflects the internal relationships of the variables among themselves. The empirical interpretation of them enables one to determine the most important economic dimensions underlying the Canadian urban system. However, the objective of the application of

Figure 4. Research Design of the Thesis


I Stage: Preparation
II Stage: Factor Analysis
III Stage: Interpretation of the Results
Formulation of the Problem
The Choice of the Principal-Component Technique
Selection of Urban Units (n cases) 1971(133), 1981(140)
Selection of Variables (k variables) 1971, 1981(27)
1971 Data Matrix A (n×k) 133 27
1981 Data Matrix A (n×k) 140 27
Standardized 1971 Data Matrix Z (n×zk) 133 27
Standardized 1981 Data Matrix Z (n×zk) 140 27
Correlation Matrix 1971 C (k×k) 27 27
Correlation Matrix 1981 C (k×k) 27 27
Factor Matrix 1971 R (k×F) 27 6
Empirical Interpretation of Factors (Dimensions) 6
Empirical Interpretation of Factors (Dimensions) 6
Factor Matrix 1981 R (k×F) 27 6
Factor Score Matrix 1971 RS (n×F) 133 6
Plotting Factor Scores on Maps
Plotting Factor Scores on Maps
Factor Score Matrix 1981 RS (n×F) 140 6
Interpretation of Changes in the Economic Dimensions 1971-1981
Four Dimensional Typology of Cities 1971 (15 Types)
Four Dimensional Typology of Cities 1981 (15 Types)
Examination of the Economic Changes Within the Canadian Urban System 1971-1981
Spatial Distribution of the Types of Cities
Spatial Distribution of the Types of Cities
Ranking of the Canadian Cities on the First Dimension
Final Results. Changes in the Canadian Urban System 1971-1981

principal-component analysis in geography is to determine a spatial distribution of the respective dimensions (see p.21). This objective will be achieved through calculation of the factor score matrix *RS*(n x F) where, *n*, stands for cities and, *F*, factors. This matrix will be calculated by using the factor loadings, *f*, as weights to modify the standardized data, *zk*. This can be obtained by multiplying the matrix ***Z*** by the matrix ***R***:

$$Z(n \times zk)\, R(k \times F) = RF(n \times F)$$

3.2 Interpretation of Factor Spaces and Factor Score Maps

Geographers are particularly interested in the factor scores because they relate the results of the factor analysis to the observations as units in space and, therefore, the spatial patterns associated with the factors. Factor scores can be presented in two different ways, that is in factor space or geographical space.

Abstract factor space refers to a space defined by two axes representing two of the factors. By plotting the factor scores, *fs*, into two dimensional Cartesian space represented by any two of the dimensions, *F*, the distribution of cities in terms of similarities between them on the two dimensions can be examined. In this way all dimensions defined in the analysis can be represented in terms of only two factors. This has theoretical advantages in that one can begin a search for the tendencies within the factor matrix which lie behind all factors extracted.

The second way of presenting factor scores is to plot them on maps. Because the columns, *n*, of the factor score matrix *RS* show the values for every urban unit on the factors, *F*, it follows that each column's values can be mapped to show the pattern of the column factor in geographical space. This is the most concrete expression of the whole factoring process, and therefore, this technique will be adopted in this thesis.

In order to analyze the distribution of the economic dimensions of the Canadian urban system in geographical space, the transformation of the factor matrix, *R*, into the factor score matrix, *RS*, will be performed separately for 1971 and 1981. Then the extracted factor scores, *fs*, will be mapped in three discrete intervals: above +0.5 (high positive correlation with a dimension), +0.5 to -0.5 (no significant correlation) and below -0.5 (high negative correlation) for each point in time. In this way the clusters of cities associated with the same dimension can be examined. The resulting spatial distribution when associated together with the empirical interpretation of the factors will enable conclusions to be drawn about the most important dimensions of the Canadian urban system in 1971 and 1981.

3.3 Interpretation of Factor Patterns

In order to determine the economic changes within the system over time, the spatial pattern of the dimensions in 1971 and 1981 will be examined in more detail. This will be achieved through a comparision of the factor matrices *R*(1971) and *R*(1981) Figure 4. In this way the major shifts in the factor loadings of the economic dimensions will be inspected. These changes will be examined in relation to the economic dimensions model of the Canadian urban system introduced in Chapter I.

The next step will be to determine the spatial changes within the Canadian urban system between 1971 and 1981 in terms of all extracted dimensions. This goal will be achieved through an examination of the economic profiles of the Canadian cities with reference to their association with all extracted dimensions simultaneously. In order to determine the associations of the cities with all dimensions the most significant factor scores, *fs*, (i.e. factor scores over or equal +1.0) will be used to develop a typology of the Canadian cities. In other words, cities which will have significant factor scores on at least one dimension will be grouped together into classes (major economic types), for 1971 and again for 1981. Then, the resulting groups of cities will be mapped according to their economic type. By comparing the distribution of the economic types of cities in 1971 and 1981 in geographical space, conclusions about the economic changes within the Canadian urban system can be drawn (Figure 4.).

The last part of the thesis research-design is a summary of the findings. The results from each subsequent step of the analysis will be compared and summarized.

Additionally, an assessment of the applicability of the economic dimensions model of the Canadian urban system applied in the thesis will be given.

IV. ANALYSIS OF THE RESULTS

In this chapter the primary stress is on interpretation of the factor loadings and factor scores generated from the original 1971 and 1981 data matrices. The chapter is divided into two major parts; the first concerns an interpretation of the results for 1971 and the second for 1981. This interpretation will allow the determination of economic dimensions of the Canadian urban system. After an analysis of the factor matrix, the discussion of each of the dimensions will be arranged into three segments. The first one will comprise the name of the dimension and the percentage of its cumulative explanation. The second will be a detailed interpretation of the most significant factor loadings on each variable. The third will comprise a graphical representation of the extracted factor scores, i.e. ranking of the cities, distribution of the factor scores in geographical space and finally an interpretation of the dimensions in two dimensional factor space.

4.1 Interpretation of the Factor Matrix 1971

The first six factors account for 64.2% of the variation in the data matrix (Table 6.). Because of the relatively low level of the overall cumulative explanation, the degree to which the variation in the individual variables has been subsumed by the six components is given in Table 6. A measure of this has been obtained by summing the squares of the loadings of each variable on each component and expressing this sum as a percentage.

The variable which is least adequately accounted for is - males participation ratio (M4). Only 8.2% of the variation in the variable is subsumed by the six components. This variable, therefore, does not correlate significantly with any of the major six economic dimensions of the Canadian urban system in 1971. There are five other variables which account for less than 50% of the total variation. There are, total population (POP1, 46.2%), male to female ratio in the labor force (R14, 24.8%), occupations in social sciences (R17, 38.6%), occupations in religious services (R18, 20.5%) and material handling occupations (R31, 40.1%). None of these variables strongly correlates with the dimensions yielded.

Table 6. Factor Matrix 1971

Code	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Adequacy
POP1	0.33	0.23	0.02	0.28	-0.19	0.43	46.2
CH2	0.12	0.57	0.19	-0.40	0.08	0.11	55.4
M4	-0.03	0.03	0.24	-0.11	-0.03	0.10	8.2
M5	-0.39	-0.30	-0.26	0.25	0.53	0.31	74.9
F9	0.61	0.33	0.41	0.05	-0.24	-0.23	76.2
F10	-0.49	-0.27	-0.53	-0.12	-0.03	0.40	76.9
R14	-0.24	0.16	-0.18	-0.22	-0.19	0.22	24.8
R15	0.69	0.21	0.06	0.39	0.18	0.37	84.5
R16	0.50	0.20	0.11	0.03	-0.23	0.47	57.7
R17	0.30	-0.33	0.40	-0.001	0.07	0.15	38.6
R18	0.07	-0.29	-0.11	-0.04	0.30	-0.11	20.5
R19	0.10	-0.40	-0.20	0.19	0.62	0.16	65.6
R20	0.46	-0.31	0.24	0.05	0.35	-0.42	66.7
R21	-0.38	-0.36	0.67	0.09	-0.01	0.11	74.3
R22	0.77	0.32	0.14	0.25	0.05	0.22	82.8
R23	0.49	0.04	0.10	0.06	0.53	-0.22	58.5
R24	0.23	-0.58	-0.19	-0.45	-0.49	-0.08	87.4
R25	-0.49	0.16	0.01	-0.51	0.02	0.12	54.1
R26	-0.64	0.05	-0.13	0.46	-0.001	-0.05	64.3
R27	-0.55	-0.14	0.58	0.29	-0.19	0.05	78.1
R28	0.01	-0.44	-0.46	0.47	-0.09	-0.23	68.7
R29	-0.20	0.39	0.18	-0.50	0.52	0.15	76.7
R30	-0.20	0.36	0.32	-0.45	0.38	0.04	62.0
R31	-0.29	0.48	-0.05	0.02	0.002	-0.29	40.1
R32	-0.49	-0.30	0.73	0.12	-0.08	0.10	89.4
R33	-0.80	0.26	0.30	-0.40	0.02	-0.07	96.3
R34	0.77	-0.51	0.09	-0.16	-0.08	0.02	89.3
Eigen	5.65	2.97	2.80	2.30	2.11	1.49	
% of var.	20.9%	11.0%	10.4%	8.5%	7.8%	5.5%	
Cum. %	20.9%	31.9%	42.3%	50.8%	58.6%	64.2%	

Adequacy: the degree to which the variation in the individual variables has been subsumed by the six factors.

% of var.: the sum of the squared factor loadings.

Cum. % : The proportion of the total variation summarized by the factors.

The variables most strongly correlated with all six dimensions are secondary employment (R33, 96.3%), other craft occupations (R31, 89.3%), tertiary employment (R34, 89.3%) and service occupations (R24, 87.4%). Therefore, it can be expected that bipolar relationships between secondary and tertiary employment will strongly emerge on the loadings yielded.

4.2 The First and the Second Dimensions in 1971

The first dimension can be intepreted as indexing the metropolitan, white-collar, service-administrative urban centers. It accounts for 20.9% of the total variation in the data matrix. The highest positive loading is associated with the tertiary employment (R34), which accounts for nearly 60% of the explanation on the first dimension (Table 7.). Variables, managerial and administrative occupations(R15) and occupations in natural sciences (R16), account for 60.7% and 25.0% of the variation respectively. Both are components of tertiary employment, confirming the white-collar occupation's domination of this dimension. Another variable highly loaded on this dimension is F9 - the female participation ratio which accounts for 37.8% of the explanation. This variable indicates that cities associated with the dimension have above average female employment. This correlation is due mostly to the high loading on managerial and administrative occupations in which most of the women are employed (Table 7.).

The interpretation of the dimension is confirmed by the negative loadings on the first factor (Table 7.). The strongest negative loading is correlated with secondary employment (R33, 64.0%), indicating a reverse correlation between tertiary and secondary sectors of industry among the employment profiles of Canadian cities. The remaining two, very high negative loadings, processing occupations (R26, 41.0%) and machinery occupations (R27, 30.5%) are components of secondary employment (see definition of secondary employment Table 4.); therefore, they contribute to the interpretation of the dimension.

Table 7. Summary of Factor Loadings 1971

Factor I			Factor II			Factor III			Factor IV			Factor V			Factor VI		
Name	Load.	% Exp.	Name	Load.	% Exp.	Name	Load.	% Exp.	Name	Load.	% Exp.	Name	Load.	% Exp.	Name	Load.	% Exp.
R22	0.77	60.7	CH2	0.57	32.5	R32	0.73	53.2	R28	0.47	22.1	R19	0.62	38.4	R16	0.47	22.1
R34	0.77	59.5	R31	0.48	23.0	R21	0.67	44.9	R26	0.46	21.2	R23	0.53	28.1	POP1	0.43	18.5
R15	0.68	47.4	R28	0.43	18.5	R27	0.57	32.5	R33	0.40	16.0	R29	0.53	28.0	F10	0.40	16.0
F9	0.61	37.8	R29	0.39	15.2	F9	0.41	16.8	R15	0.39	15.2	M5	0.53	28.0	R15	0.37	13.7
R16	0.49	24.9	R30	0.36	13.0	R17	0.40	16.0	R27	0.29	8.4	R30	0.38	14.4	M5	0.31	9.6
R23	0.49	24.3	F9	0.33	10.9	R30	0.32	10.2	POP1	0.28	7.8	R20	0.35	12.2	R14	0.22	4.8
R20	0.46	21.3	R22	0.32	10.2	R33	0.30	9.0	R22	0.25	6.2	R18	0.30	9.0	R22	0.22	4.7
POP1	0.33	11.0	R33	0.26	6.8	M4	0.24	5.8	M5	0.24	5.8	R15	0.18	3.2	R19	0.16	2.6
R17	0.30	9.0	POP1	0.23	5.3	R20	0.24	5.7	R19	0.19	3.6	CH2	0.08	0.6	R29	0.15	2.2
R24	0.23	5.3	R15	0.21	4.4	CH2	0.19	3.6	R32	0.12	1.4	R17	0.07	0.5	R17	0.15	2.1
CH2	0.12	1.4	R16	0.20	4.0	R29	0.18	3.2	R21	0.09	0.8	R22	0.05	0.2	R25	0.12	1.4
R19	0.10	1.0	R14	0.16	2.6	R22	0.14	2.0	R23	0.06	0.4	R25	0.02	0.0	R21	0.11	1.2
R18	0.07	0.4	R25	0.16	2.5	R16	0.11	1.2	F9	0.05	0.2	R33	0.02	0.0	CH2	0.11	1.1
R28	0.005	0.0	R26	0.05	0.2	R23	0.10	1.0	R20	0.05	0.2	R31	0.002	0.0	R32	0.10	1.0
M4	-0.03	0.1	R23	0.04	0.1	R34	0.09	0.8	R16	0.03	0.1	R26	0.00	0.0	M4	0.10	1.0
R30	-0.19	3.6	M4	0.03	0.1	R15	0.07	0.5	R31	0.02	0.0	R21	-0.01	0.0	R27	0.05	0.2
R29	-0.20	4.0	R27	-0.14	2.0	POP1	0.02	0.0	R17	0.00	0.0	M4	-0.03	0.1	R30	0.04	0.2
R14	-0.24	5.8	F10	-0.26	6.8	R25	0.01	0.0	R18	-0.04	0.2	F10	-0.03	0.1	R34	0.02	0.0
R31	-0.29	8.4	R18	-0.28	7.8	R31	-0.05	0.2	M4	-0.11	1.2	R34	-0.08	0.6	R26	-0.05	0.2
R21	-0.38	14.4	R32	-0.30	9.0	R18	-0.11	1.2	F10	-0.12	1.4	R32	-0.09	0.8	R33	-0.07	0.5
M5	-0.39	15.4	M5	-0.30	9.0	R26	-0.13	1.7	R34	-0.16	2.6	R28	-0.09	0.8	R24	-0.08	0.6
R32	-0.48	24.0	R20	-0.31	9.6	R14	-0.18	3.2	R14	-0.22	4.8	R27	-0.19	3.6	R18	-0.11	1.2
R25	-0.49	24.4	R17	-0.33	10.9	R24	-0.19	3.6	CH2	-0.40	16.0	POP1	-0.19	3.7	R23	-0.22	4.8
F10	-0.49	24.5	R21	-0.36	13.0	R19	-0.20	4.0	R24	-0.45	20.2	R14	-0.19	3.7	R28	-0.23	5.3
R27	-0.55	30.5	R19	-0.40	16.0	M5	-0.26	6.8	R20	-0.45	20.3	R16	-0.23	5.3	F9	-0.23	5.4
R26	-0.63	40.9	R34	-0.51	26.0	R28	-0.46	21.2	R29	-0.50	25.0	F9	-0.24	5.8	R31	-0.29	8.4
R33	-0.79	63.4	R24	-0.58	33.6	F10	-0.53	28.1	R25	-0.51	26.0	R24	-0.49	24.0	R20	-0.42	17.6

Name: Name of Variable.

Load.: Loading of Variable.

% Exp.: Percent of Explanation.

The bipolar nature of the first dimension is based on the reverse correlation between tertiary and secondary sectors of employment. This relation is confirmed by the distribution of the positive and negative loadings on this factor. Almost all components of the tertiary sector load positively on it, while the reverse association can be noted for components of secondary employment.

It can be expected that the cities associated with this dimension are characterized by unusually high percentages of white-collar, service occupations in their employment structures and high female participation ratios. This combination occurs mostly in large metropolitan cities where the high level of tertiary employment causes overall high female employment. The negative correlation with the secondary sector, can be interpreted as caused by a relatively low level of employment in this sector as compared to the tertiary sector. This type of employment structure occurs mostly in political and administrative centers of the nation such as Halifax, Ottawa-Hull or Calgary.

In Table 8., the cities with the highest and the lowest factor scores are listed. To reiterate, the factor scores allow cities to be ranked according to their relative position on the first dimension. A high factor score indicates a city whose employment structure is very strongly associated with the first dimension. The city which scores highest on this scale is Ottawa-Hull, the political and administrative capital of Canada. Among 35 cities with the highest scores on this dimension occur all the provincial and administrative centers of the country (Figures 5.1 and 5.2). The remaining cities in this group can be described as large service and distribution centers which are most closely associated with the high percentages of the labor force employed in the tertiary sector (eg. Kingston, Red Deer, Brockville - Table 8.).

At the other end of the scale there are mining towns like Flin Flon, Sydney Mines, Timmins and generally small non-service towns. Among these, the larger cities have mostly positive scores, because the number of service functions increases with the city size due to the needs of the inhabitants and inhabitants of the surrounding region. With the smaller centers, a negative score indicates the absence of any specialized function related to tertiary employment.

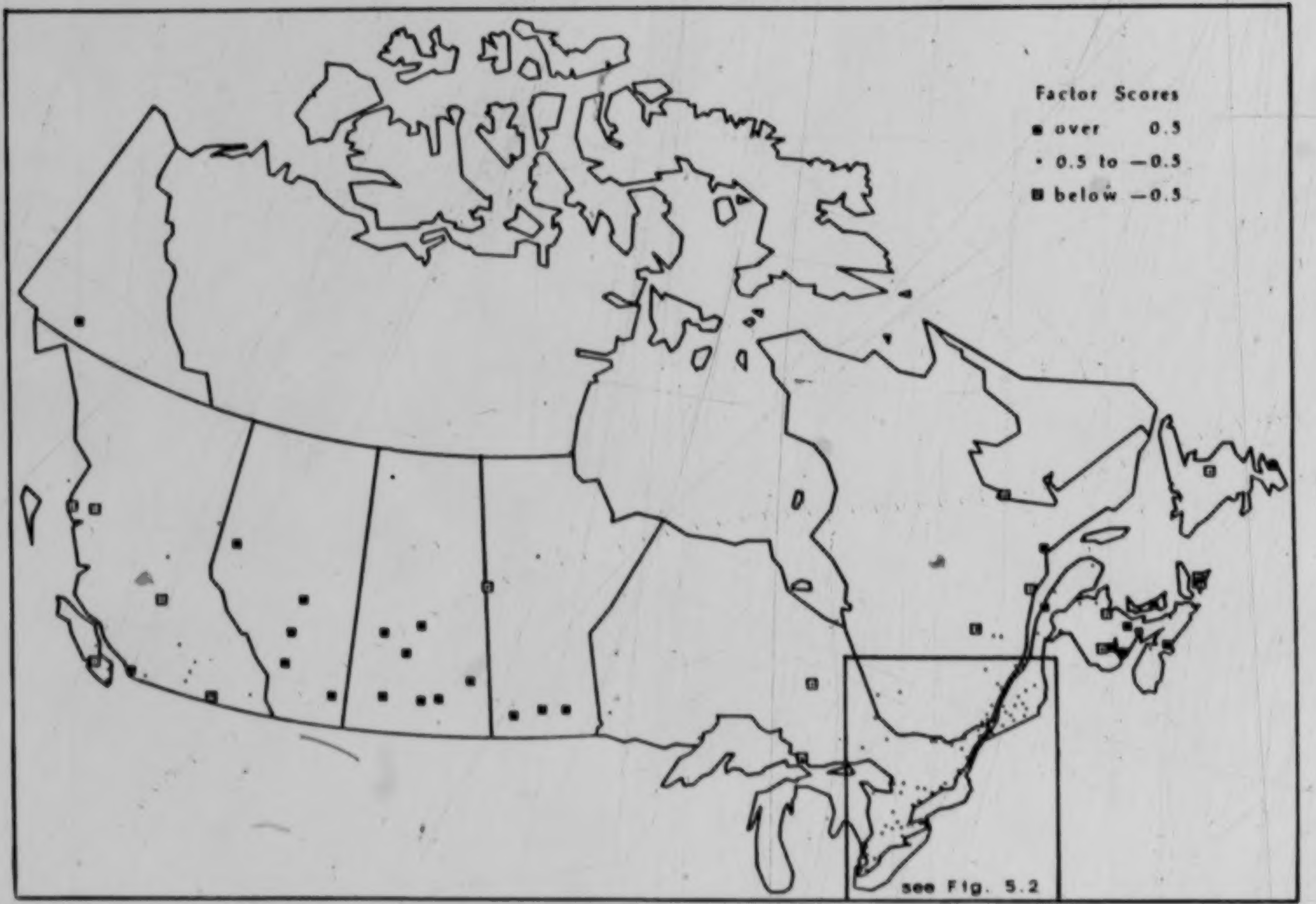

Factor Scores
■ over 0.5
• 0.5 to −0.5
▣ below −0.5
see Fig. 5.2

Figure 5.1 Spatial Distribution - the Values of Factor I: 1971

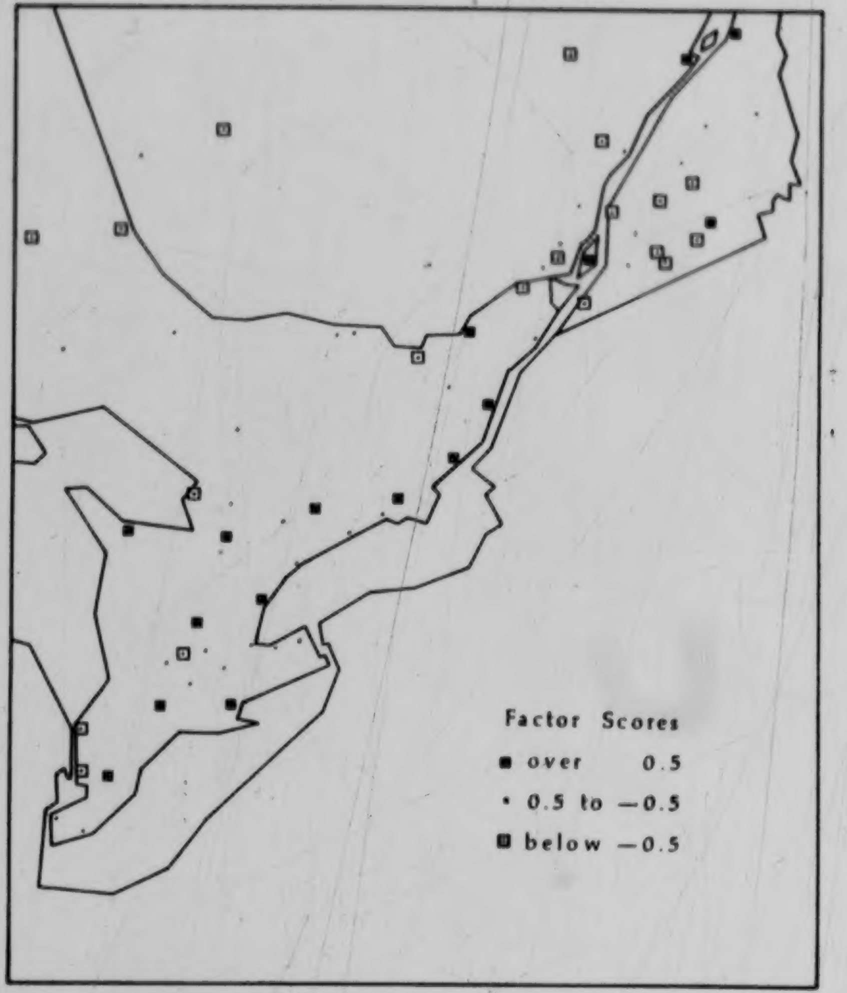

Factor Scores
■ over 0.5
• 0.5 to −0.5
▣ below −0.5

Figure 5.2 Spatial Distribution - the Values of Factor I: 1971

Table 8. Factor Scores on Factor I. 1971

Score	City	Province	Score	City	Province
2.53	Ottawa-Hull	O.-Q.	-0.49	Kenora	O.
2.00	Fredericton	N.B.	-0.51	Sault Ste.Marie	O.
1.88	Halifax	N.S.	-0.53	Timmins	O.
1.79	Toronto	O.	-0.54	Granby	Q.
1.75	Regina	S.	-0.58	Sorel	Q.
1.62	Calgary	A.	-0.58	Newcastle	N.B.
1.48	Quebec	Q.	-0.63	Haileybury	O.
1.39	Montreal	Q.	-0.64	Cowansville	Q.
1.32	Kingston	O.	-0.71	Drummondville	Q.
1.31	Winnipeg	M.	-0.74	Baie-Comeau	Q.
1.27	Red Deer	A.	-0.79	Baie-Comeau	Q.
1.26	Brockville	O.	-0.79	Leamington	O.
1.25	Edmonton	A.	-0.80	Vai d'Or	Q.
1.21	Charlottetown	P.E.I.	-0.81	Sydney	N.S.
1.18	Saskatoon	S.	-0.88	Midland	O.
1.18	Rimouski	Q.	-0.95	Valleyfield	B.C.
1.16	Yorkton	S.	-0.98	Williams Lake	B.C.
1.15	St.John's	Nfld.	-1.04	Terrace	B.C.
1.13	London	O.	-1.09	La Tuque	Q.
1.08	Moncton	N.B.	-1.16	Wallaceburg	O.
1.08	Brandon	M.	-1.16	Shawinigan	Q.
1.07	Swift Current	S.	-1.25	Prince Rupert	B.C.
0.99	Belleville	O.	-1.32	Kapuskasing	O.
0.96	Portage la Prairie	M.	-1.38	Sydney Mines	N.S.
0.96	Victoria	B.C.	-1.46	Trail	B.C.
0.92	Vancouver	B.C.	-1.54	New Hamburg	O.
0.89	North Battleford	S.	-1.61	Magog	Q.
0.88	Peterborough	O.	-1.65	Lachute	Q.
0.87	Sherbrooke	Q.	-1.71	Hawkesbury	O.-Q.
0.85	Grande Prairie	A.	-1.72	Arnprior	O.
0.84	Prince Albert	S.	-1.77	Dolbeau	Q.
0.83	Guelph	O.	-1.96	Port Alberni	B.C.
0.71	Riviere-du-Loup	Q.	-2.28	Flin Flon	M.-S.
0.71	Whitehorse	Y.	-2.47	Labrador City	Nfld.
0.63	Owen Sound	O.	-2.65	Asbestos	Q.

The second dimension extracted from the 1971 data matrix indexes high female employment in manufacturing and low unemployment in the secondary sector. This dimension explains 11.0% of the total variation in the data matrix (Table 7.). The only high positive factor loading which accounts for more than 25.0% of the total variance in the dimension is associated with the population change ratio (CH2, 35.5%). The remaining positive loadings are correlated with secondary employment, i.e. material handling occupations (R31, 23.0%), product fabricating occupations (R28, 18.5%) and construction occupations (R29, 15.2%).

The negative loadings on service occupations (R24, 33.6%) and tertiary employment (R34, 26.0%) indicate a negative correlation of the variables with the dimension. Interestingly, the loadings of the second dimension on tertiary (R34, 0.26) and secondary (R33, -0.30) occupations are opposite to the loadings of these variables on the first dimension. Hence, the second dimension indexes a reverse type of employment profile of a city to that indexed by the first dimension. However, this interpretation explains only a part of the second factor. The remaining high positive factor loading of the variable - female participation ratio (F9, 16.8%) - indicates association of the second dimension with a relatively high level of female employment in manufacturing (Table 8.).

The negative loadings of male and female unemployment rates (F10, 6.8% and M5, 9.0%) show that the dimension is associated with the cities characterized by high female manufacturing employment and low rates of unemployment in the secondary sector.

In Table 9., the cities are ranked according to their respective factor scores on the second dimension. The areal distribution of the cities associated with this dimension is shown in Figures 6.1 and 6.2. The highest ranking cities are located in British Columbia - Cranbrook, Prince George, Port Alberni, Kamloops, Kelowna and Vancouver. Also the major manufacturing centers of the heartland - Montreal and Toronto - rank high on this dimension. The dimension seems also to categorize the prairie type of city such as - Edmonton, Calgary and Grande Prairie.

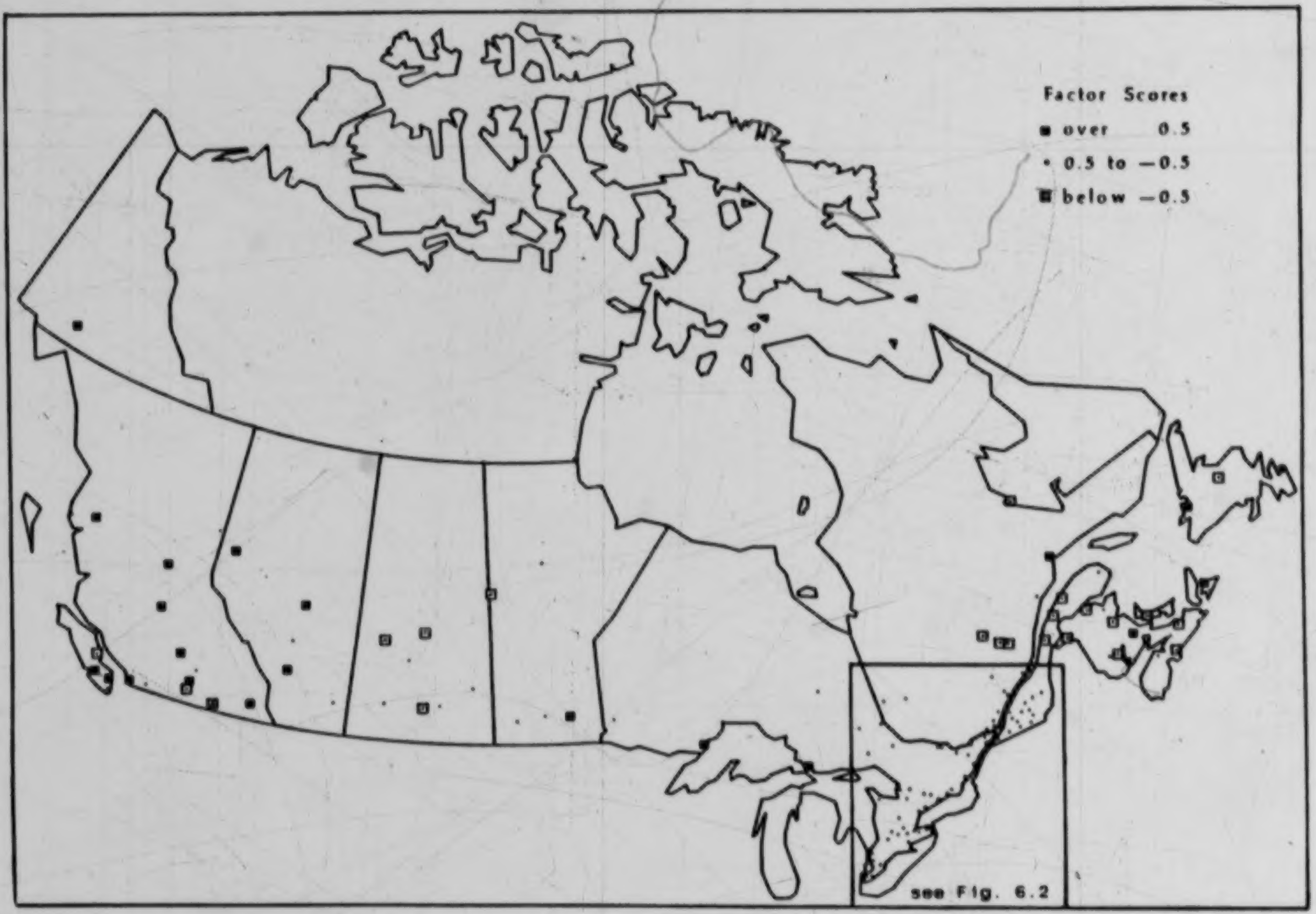

Factor Scores
■ over 0.5
• 0.5 to −0.5
▣ below −0.5
see Fig. 6.2

Figure 6.1 Spatial Distribution - the Values of Factor II: 1971

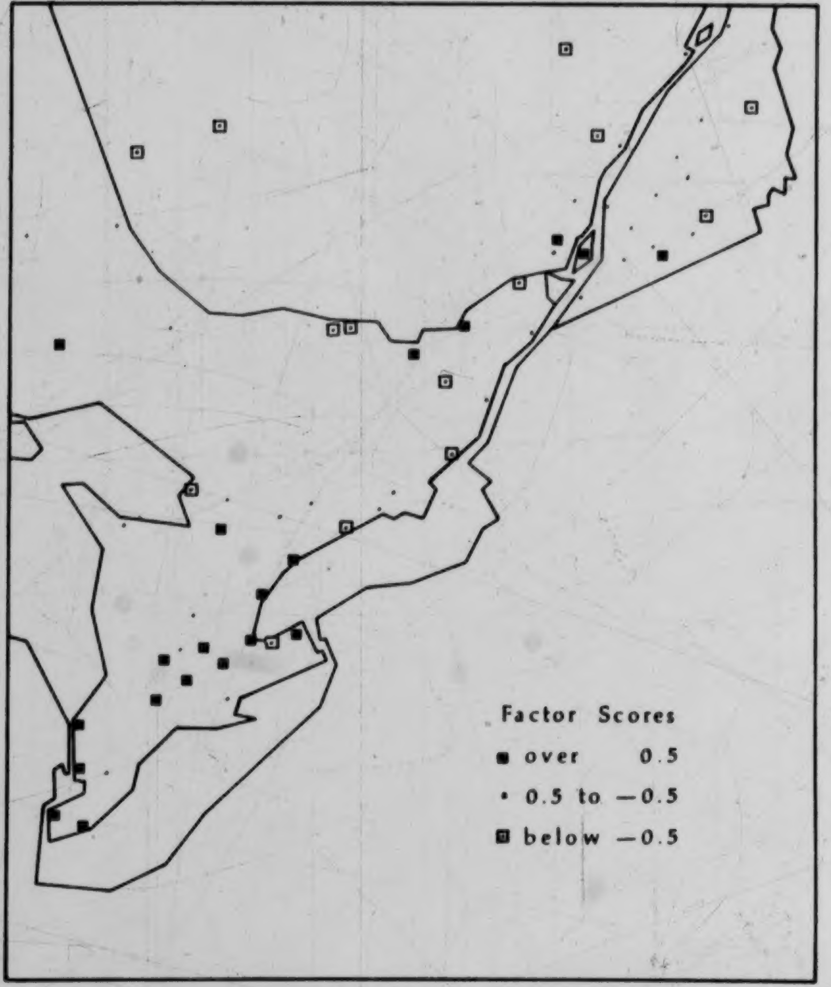

Factor Scores
■ over 0.5
• 0.5 to —0.5
▣ below —0.5

Figure 6.2 Spatial Distribution - the Values of Factor II: 1971

Table 9. Factor Scores on Factor II. 1971

Score	City	Province	Score	City	Province
2.47	Cranbrook	B.C.	-0.54	Magog	Q.
1.87	Kitchener	O.	-0.55	Prince Albert	S.
1.86	Whitehorse	Y.	-0.55	Halifax	N.S.
1.70	Prince George	B.C.	-0.62	Matane	Q.
1.69	Sept-Iles	Q.	-0.62	Grand Falls	Nfld.
1.68	Port Alberni	B.C.	-0.65	La Tuque	Q.
1.45	Toronto	O.	-0.69	Edmundston	N.B.
1.32	Kamloops	B.C.	-0.71	Hawkesbury	O.
1.25	Arnprior	O.	-0.79	Joliette	Q.
1.21	Kelowna	B.C.	-0.81	Shawinigan	Q.
1.20	Sudbury	O.	-0.82	Dolbeau	Q.
1.05	Calgary	A.	-0.95	Sherbrooke	Q.
1.03	Hamilton	O.	-0.95	Trail	B.C.
1.00	Labrador City	Nfld.	-0.98	Kingston	O.
0.99	Montreal	Q.	-0.98	New Glasgow	N.S.
0.99	Vancouver	B.C.	-1.03	Moose Jaw	S.
0.95	Sault Ste.Marie	O.	-1.06	Campbellton	N.B.
0.91	Grande Prairie	A.	-1.09	Chicoutimi-Jonquiere	Q.
0.90	Nanaimo	B.C.			
0.89	Penticton	B.C.	-1.10	Rimouski	Q.
0.88	Leamington	O.	-1.11	Midland	O.
0.88	Brantford	O.	-1.24	Riviere-du-Loup	Q.
0.85	Williams Lake	B.C.	-1.24	Saint Georges	Q
0.81	Edmonton	A.	-1.24	Lachute	Q.
0.81	Barrie	O.	-1.33	Alma	Q.
0.71	Terrace	B.C.	-1.33	Newcastle	N.B.
0.70	Saskatoon	S.	-1.36	Cobourg	O.
0.69	Windsor	O.	-1.42	Summerside	P.E.I.
0.68	Oshawa	O.	-1.51	Val d'Or	Q.
0.67	Thunder Bay	O.	-1.61	North Battleford	S.
0.67	Winnipeg	M.	-1.65	Portage la Prairie	M.
0.66	Stratford	O.	-1.70	Flin Flon	M.-S.
0.65	Cowansville	Q.	-1.84	Courtenay	B.C.
0.62	St.Catharines-Niagara	O.	-2.01	Pembroke	O.
			-2.85	Petawawa	O.
0.62	St.Jean	Q.	-4.30	Oromocto	O.

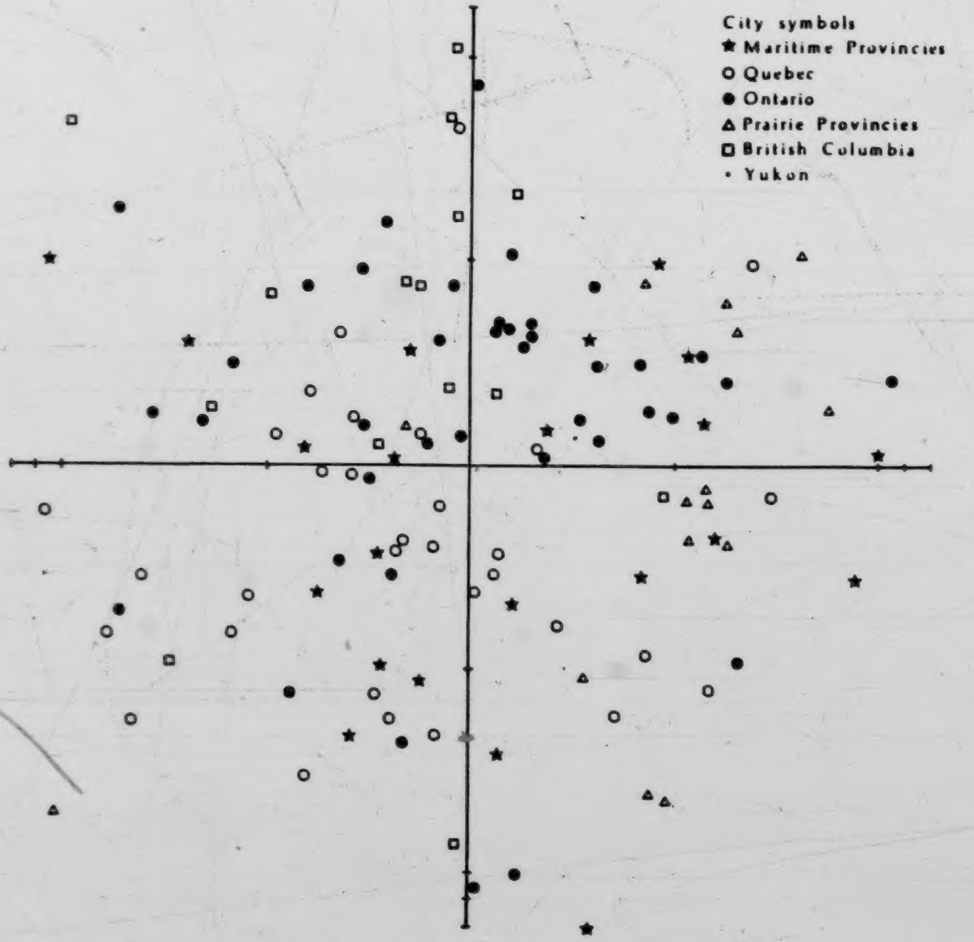
The interpretation of the first two dimensions is confirmed by plotting the component scores into two dimensional factor space shown on the diagram in Figure 7. The first dimension i.e. metropolitan, white-collar, service-administrative centers, represented by the horizontal axis, reveals that there are no clusters of cities by provincies. The relative position of the cities in two dimensional space formed by the vertical axis representing the second dimension - high level of female employment in manufacturing and a low unemployment level, also shows no clear clusters of cities.

The distribution in the two dimensional factor space indicates an even spread of the population of Canadian cities along the first and the second dimensions as referred to by their economic structures. However, it has to be noted that the cities of Ontario tend to spread evenly only along the axis indicating the first dimension and on the positive side of the second (Figure 7.). It can be concluded that the employment profiles of urban centers in Ontario represent a combination of the first dimension with attributes indexed by the second one, such as: high female employment in manufacturing and relatively low levels of unemployment. This tendency is quite opposite to the that of cities of Quebec which load in most cases negatively on both dimensions except for Montreal and Victoriaville (Figure 7.).

The first two dimensions have determined, therefore, the fundamental regional contrast between the cities in the Canadian heartland. The cities of Quebec are in general characterized by a higher level of unemployment than in Ontario and lower female participation ratios (eg. Saint George, Riviere du Loup and Rimouski).

The cities of British Columbia form an exclusive pattern characterized by the close to zero or negative factor scores on the first dimension and in most cases, high positive scores on the second. It creates a distribution which suggests that cities in the province lack the properties of the typical metropolitan service center of the Eastern or Prairie Provinces. In other words, the cities of British Columbia lack the employment properties of the cities of Quebec and Ontario, i.e. very high levels of service employment.

Figure 7. Two Factor Space: Factor I and II: 1971



This interpretation gives a new meaning to the second dimension which reflects the basic contrasts between the Eastern and Western regions of Canada. On the negative end of the scale (Figure 7.), there are cities of Quebec; in the middle - Ontario and at the upper positive end - British Columbia. This interpretation is only partly repeated by the distribution of the factor scores of the cities in the Maritime and Prairie Provinces. The urban centers of the Maritime Provinces do not form any spatial pattern in the two dimensional space formed by the first and the second factor. The cites of the Prairie Provinces are characterized by high positive factor scores on the first dimension, indicating a service type of employment profile. All but one Prairie city (i.e. Medicine Hat) have positive loadings on the first dimension, and at the same time they are spread rather evenly along the second. The distribution on the first and the second dimension indicates an uneven degree of correlation. Cities like Edmonton or Calgary, loading highly on the second dimension (Table 9.), are characterized by high female participation ratios and low unemployment, while cities like Flin Flon or Portage la Prairie, which have high negative loadings on this dimension, are characterized by the opposite, that is low female participation ratios and high unemployment rates.

4.3 The Third and Fourth Dimensions in 1971

The third dimension indexes the service role of the many comparatively isolated communities located in Ontario, Quebec, British Columbia and the Maritime Provinces, particularly in Nova Scotia. It accounts for 10.4% of the total variation in the 1971 data matrix (Table 6.). The highest positive loadings (Table 7.) are: craft occupations such as printing, stationary engine service, utilities equipment services (R32, 53.2%) and artistic crafts (R21, 44.9%). The high loading on machinary occupations (R27, 53.2%) reflects similarities between craft occupations and manufacturing occupations requiring highly skilled workers. The high loading on the female participation ratio variable (F9, 16.8%) indicates an association of these activities with high female unemployment level. This interpretation is supported by the high negative loading on the female unemployment variable (F10, 28.1%), indicating a strong correlation between craft industries and female employment.

The cities with the highest factor scores on the third dimension are listed in Table 10. The highest positive scores are associated with the small and medium sized cities of Ontario, British Columbia and the Maritime Provinces (Figure 4.1). In particular, urban centers of Ontario and British Columbia rank high on this dimension (Figure 4.2). The opposite distribution can be noted for cities of Quebec, which generally load negatively on this dimension.

The cities with high employment in manufacturing industry and high levels of blue-collar workers are indexed by the fourth dimension. The highest loadings are associated with the product fabricating variable (R28,22.1%) and the processing occupations (R26, 21.6%). The interpretation of the dimension is supported by the high loadings on the secondary occupations variable (R33, 16.0%), managerial occupations variable (R15, 15.2%) and clerical occupations variable (R22, 6.2%). The examples of the cities with high scores on this dimension are : Magog, Montreal, Toronto, Hawkesbury, Wallaceburg and Cowansville (Table 11.).

The dimension is negatively correlated with the primary sector of industry (R25, 26.0%) and occupations in the construction industry (R29, 25.0%). These correlations index the unusually low level of occupations in the primary sector of industry in the economic profiles of cities with the high scores on the fourth dimension.

Figures 5.1 and 5.2 show the areal distribution of the urban centers associated with this dimension. Most of the cities with the high positive scores are grouped in the industrial heartland of Canada. The negative scores are associated mostly with the urban centers of the Prairie and the Maritime Provinces indicating the low levels of manufacturing employment in these regions.

The third and fourth dimensions account together for 18.9% of the total variance in the data matrix. The distribution of all urban centers according to these two dimensions is shown on the diagram in Figure 10. The relative position of the cities in the two dimensional factor space indicates the division of the Canadian urban system between heartland and frontier

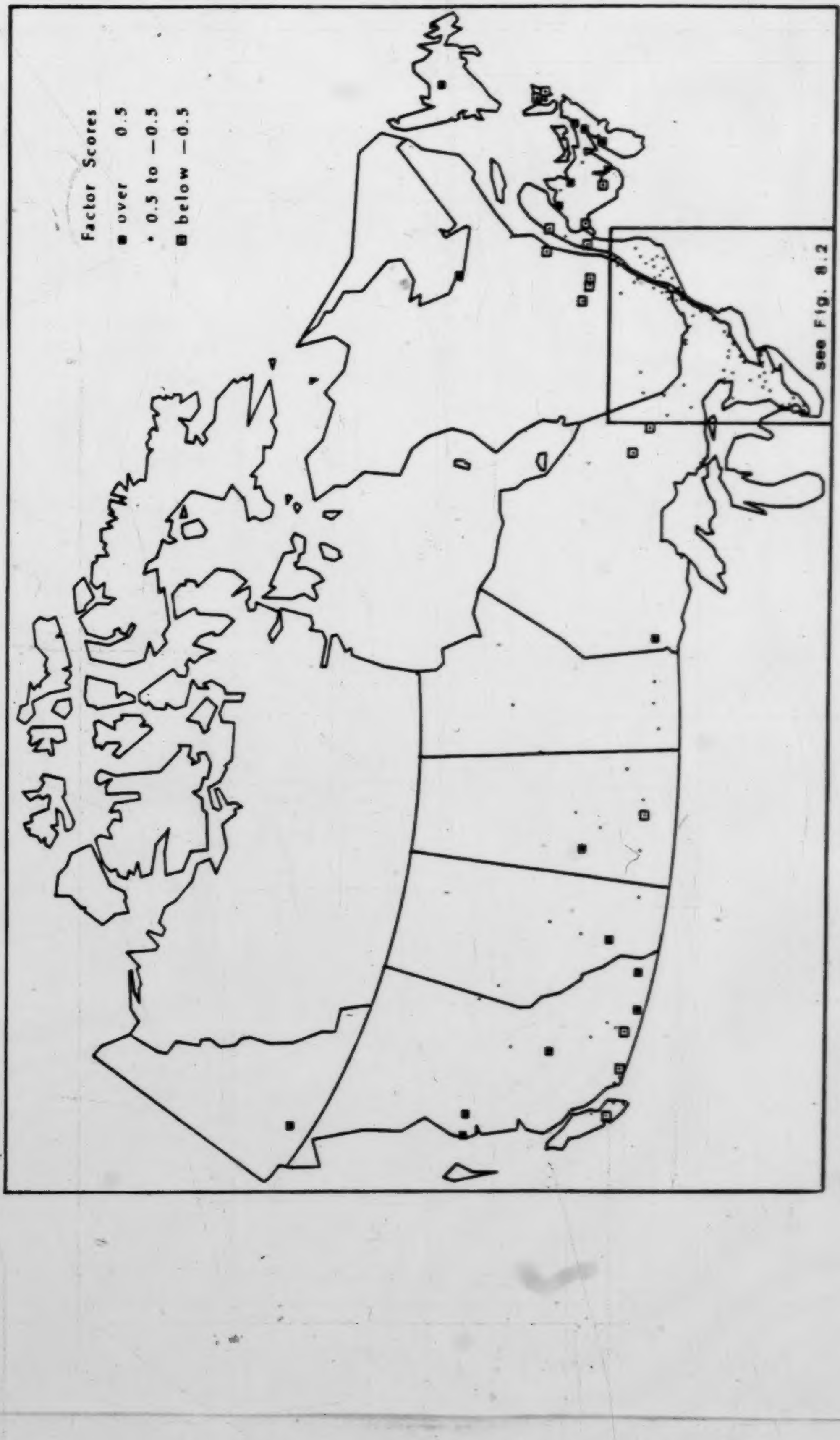

Factor Scores
■ over 0.5
• 0.5 to −0.5
▣ below −0.5
see Fig. 8.2

Figure 8.1 Spatial Distribution - the Values of Factor III: 1971

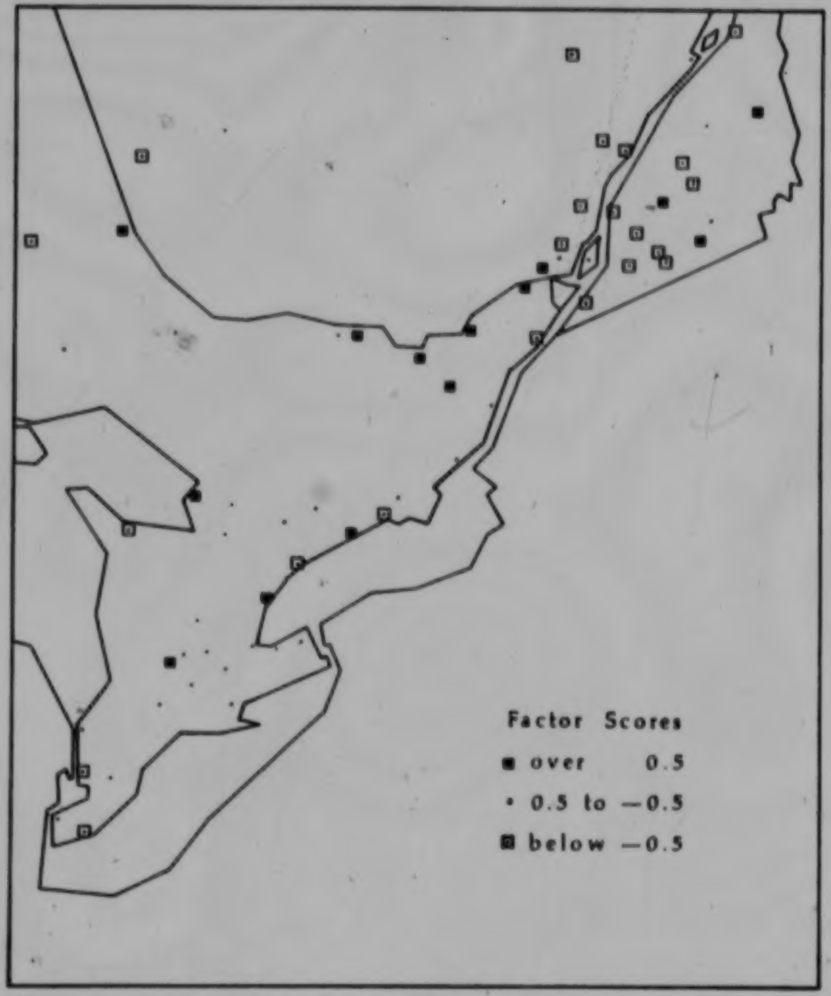

Factor Scores
■ over 0.5
• 0.5 to —0.5
▣ below —0.5

Figure 8.2 Spatial Distribution - the Values of Factor III : 1971

Table 10. Factor Scores on Factor III. 1971

Score	City	Province	Score	City	Province
3.29	Midland	O.	-0.58	Joliette	Q.
2.51	Kenora	O.	-0.61	Edmundston	N.B.
2.48	Smiths Falls	O.	-0.61	Leamington	O.
2.41	New Hamburg	O.	-0.68	Montmagny	Q.
2.08	Cobourg	O.	-0.71	Riviere-du-Loup	Q.
2.04	Pembroke	O.	-0.72	Dolbeau	Q.
2.04	Trail	B.C.	-0.76	Timmins	O.
1.97	Williams Lake	B.C.	-0.83	Cornwall	O.
1.71	Labrador City	Nfld.	-0.84	Victoria	B.C.
1.70	North Battleford	S.	-0.85	Trenton	O.
1.54	Prince Rupert	B.C.	-0.85	Sydney	N.S.
1.51	Arnprior	O.	-0.89	Chilliwack	B.C.
1.48	Truro	N.S.	-0.94	Penticton	O.
1.46	Terrace	B.C.	-0.96	Cowansville	Q.
1.36	Haileybury	O.	-0.97	Trois Rivieres	Q.
1.35	Kentville	N.S.	-0.98	St.Jerome	Q.
1.25	New Glasgow	N.S.	-1.00	Baie-Comeau	Q.
1.10	Magog	Q.	-1.01	Sydney Mines	N.S.
1.08	Campbellton	N.B.	-1.08	Matane	Q.
1.01	Lachute	Q.	-1.09	St.Hyacinthe	Q.
0.90	Hawkesbury	O.	-1.10	St.Jean	Q.
0.88	Grand Falls	Nfld.	-1.10	Petawawa	O.
0.84	Whitehorse	Y.	-1.13	Port Alberni	B.C.
0.73	Ottawa-Hull	O.-Q.	-1.14	Sorel	Q.
0.64	Cranbrook	B.C.	-1.17	Kapuskasing	Q.
0.63	Newcastle	N.B.	-1.19	Rouyn	Q.
0.62	Summerside	P.E.I.	-1.27	La Tuque	Q.
0.60	St.Georges	Q.	-1.31	Drummondville	Q.
0.56	Toronto	O.	-1.32	Valleyfield	Q.
0.54	Asbestos	Q.	-1.32	Granby	Q.
0.52	Calgary	A.	-1.41	Thetford Mines	Q.
0.46	Flin Flon	M.-S.	-1.46	Alma	Q.
0.44	Edmonton	A.	-1.46	Chicoutimi-	
0.44	Regina	S.		-Jonquiere	Q.
0.43	Halifax	N.S.	-1.91	Shawinigan	Q.
			-2.75	Oromocto	N.B.

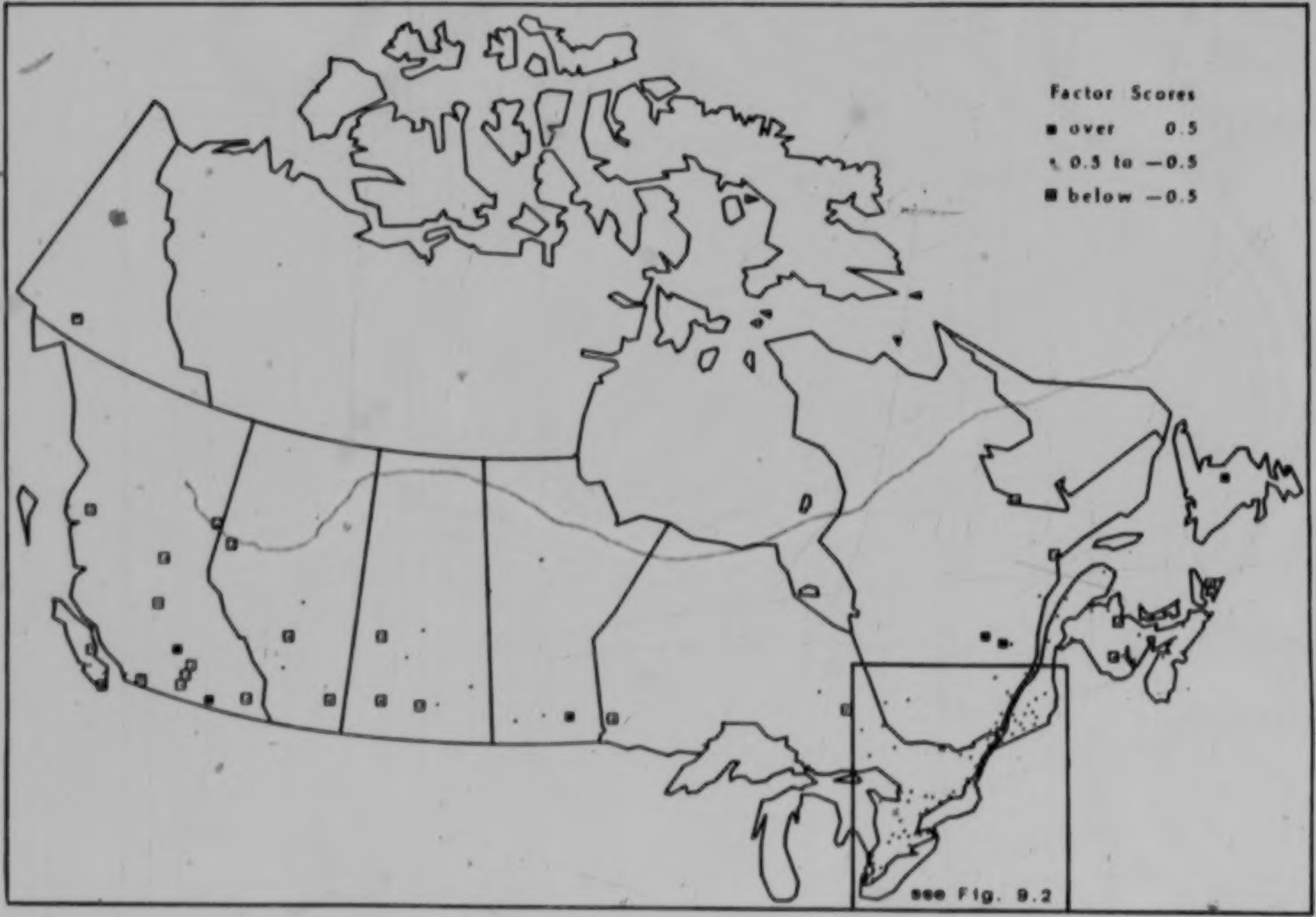

Factor Scores
■ over 0.5
· 0.5 to −0.5
▣ below −0.5
see Fig. 9.2

Figure 9.1 Spatial Distribution - the Values of Factor IV: 1971

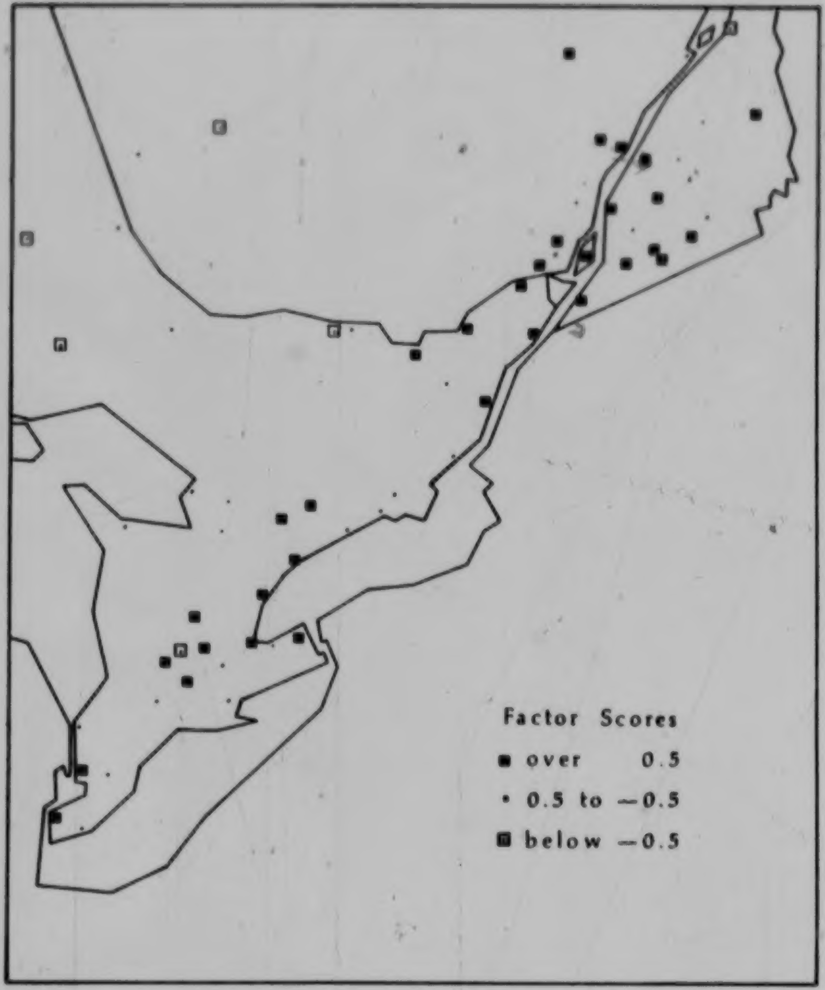
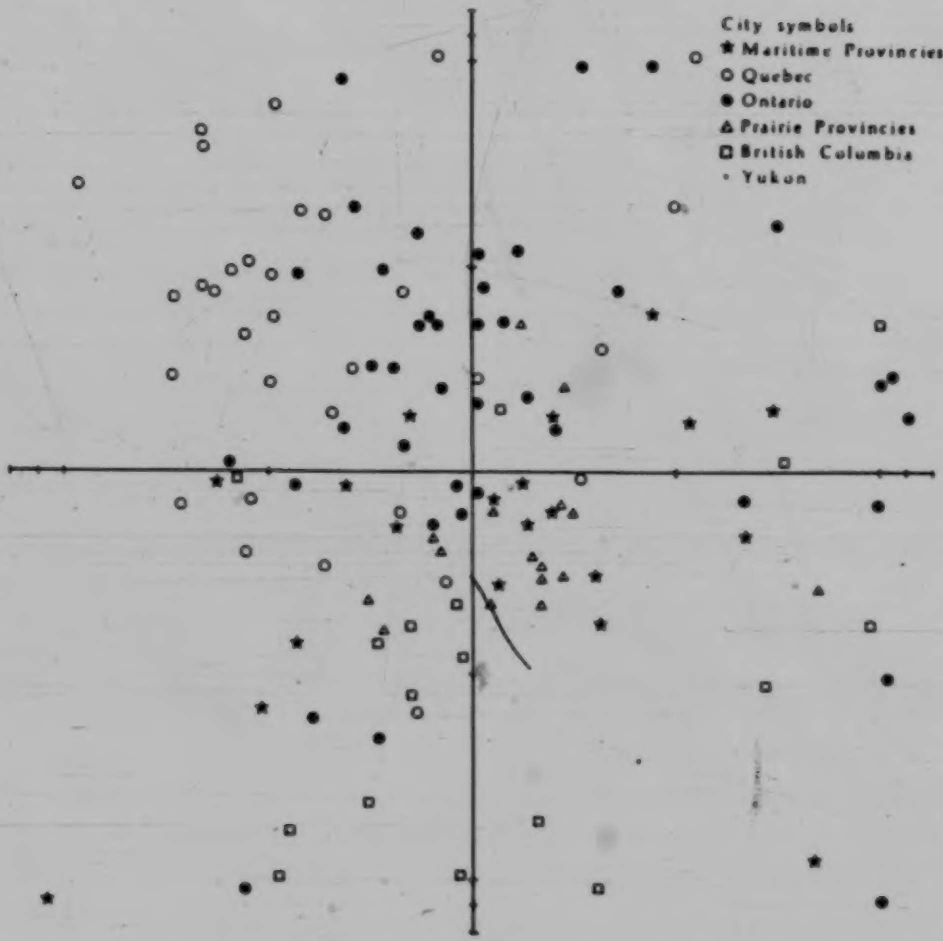

Factor Scores
■ over 0.5
• 0.5 to −0.5
▣ below −0.5

Figure 9.2 Spatirl Distribution - the Values of Factor IV: 1971

Table 11. Factor Scores on Factor IV. 1971

Score	City	Province	Score	City	Province
2.13	Magog	Q.	-0.48	Riviere-du-Loup	Q.
2.02	Montreal	Q.	-0.51	Summerside	P.E.I.
1.99	Toronto	O.	-0.53	Val d'Or	Q.
1.92	Hawkesbury	O.-Q.	-0.53	Red Deer	A.
1.91	Wallaceburg	O.	-0.57	Charlottetown	P.E.I.
1.79	Cowansville	Q.	-0.58	North Battleford	S.
1.65	Granby	Q.	-0.64	New Hamburg	O.
1.59	Drummondville	Q.	-0.64	Moose Jaw	S.
1.44	Shawinigan	Q.	-0.66	Swift Current	S.
1.37	Lachute	Q.	-0.66	Victoria	B.C.
1.29	Oshawa	O.	-0.66	Grande Prairie	A.
1.28	Victoriaville	Q.	-0.76	Dawson Creek	B.C.
1.25	Dolbeau	Q.	-0.76	Newcastle	N.B.
1.23	Arnprior	O.	-0.76	Williams Lake	B.C.
1.17	Brantford	O.	-0.79	Medicine Hat	A.
1.09	Stratford	O.	-0.84	Sydney	N.S.
1.02	St.Hyacinthe	Q.	-0.85	Vernon	B.C.
1.01	Woodstock	O.	-0.92	Prince George	B.C.
0.99	Sorel	Q.	-1.02	Kenora	O.
0.98	Windsor	O.	-1.05	Terrace	B.C.
0.97	Cornwall	O.	-1.13	Nanaimo	B.C.
0.95	Trois Rivieres	Q	-1.16	Sydney Mines	N.S.
0.90	Valleyfield	Q.	-1.19	Sept-Iles	Q.
0.90	Brockville	O.	-1.28	Timmins	O.
0.89	Ottawa-Hull	O.-Q.	-1.30	Sudbury	O.
0.89	Sherbrooke	Q.	-1.41	Whitehorse	Y.
0.88	La Tuque	Q.	-1.61	Kelowna	B.C.
0.86	Alma	Q.	-1.71	Kamloops	B.C.
0.78	Grand Falls	Nfld.	-1.76	Chilliwack	B.C.
0.76	St.Jerome	Q.	-1.97	Labrador City	Nfld.
0.75	Peterborough	O.	-1.99	Courtenay	B.C.
0.73	Owen Sound	O.	-1.99	Penticton	B.C.
0.72	Lindsay	O.	-2.24	Cranbrook	B.C.
0.72	Trail	B.C.	-2.30	Petawawa	O.
0.72	Hamilton	O.	-2.86	Oromocto	N.B.

Figure 10. Two Factor Space: Factor III and IV: 1971



(periphery) regions. All but one city with negative scores on the third dimension (called in short frontier-service dimension) and the positive scores on the specialized manufacturing dimension are located in Ontario and Quebec. On the opposite end of the scale, that is cities with negative scores on the third dimension and positive on the forth, are cities of the Prairie and Maritime Provinces. The cities with a less specialized manufacturing type of economic profile but more pronounced service employment, cluster in the remaining two quadrants of the diagram in Figure 10.

4.4 The Fifth and Sixth Dimensions in 1971

The fifth dimension is to a certain degree redundant to the third one, indexing the frontier-service centers. The highest positive loadings on the fifth dimension are: teaching occupations in primary and secondary level schools (R19, 38.4%), sales occupations (R23, 28.1%), occupations in construction industries (R29, 28.0%) and male unemployment rate (M5, 28.0%). The strongest negative loadings are associated with service occupations (R24, 24.0%) and the female participation rate (F9, 5.8%).

The high correlation with the female participation rate indicates the association of the dimension with the low level of female employment and high male unemployment rate. The dimension can be interpreted as indexing the service centers located outside metropolitan areas characterized by high male unemployment (Yeates & Garner, 1980, p.387). The spatial distribution of the urban places associated with this dimension is shown on Figures 11.1 and 11.2. The distribution is determined generally by high positive scores of the cities outside the industrial heartland of Southern Quebec and Ontario (Table 12.). Almost all cities in the Maritime and Prairie Provinces score positively on this dimension. The reverse observation can be noted for almost all cities of the industrial belt of Canada.

The sixth dimension indicates a similar type of urban economic structure to that indexed by the first dimension (Table 7.). The dimension can be interpreted as indicating large and medium size metropolitan type of urban areas within the Canadian urban system.

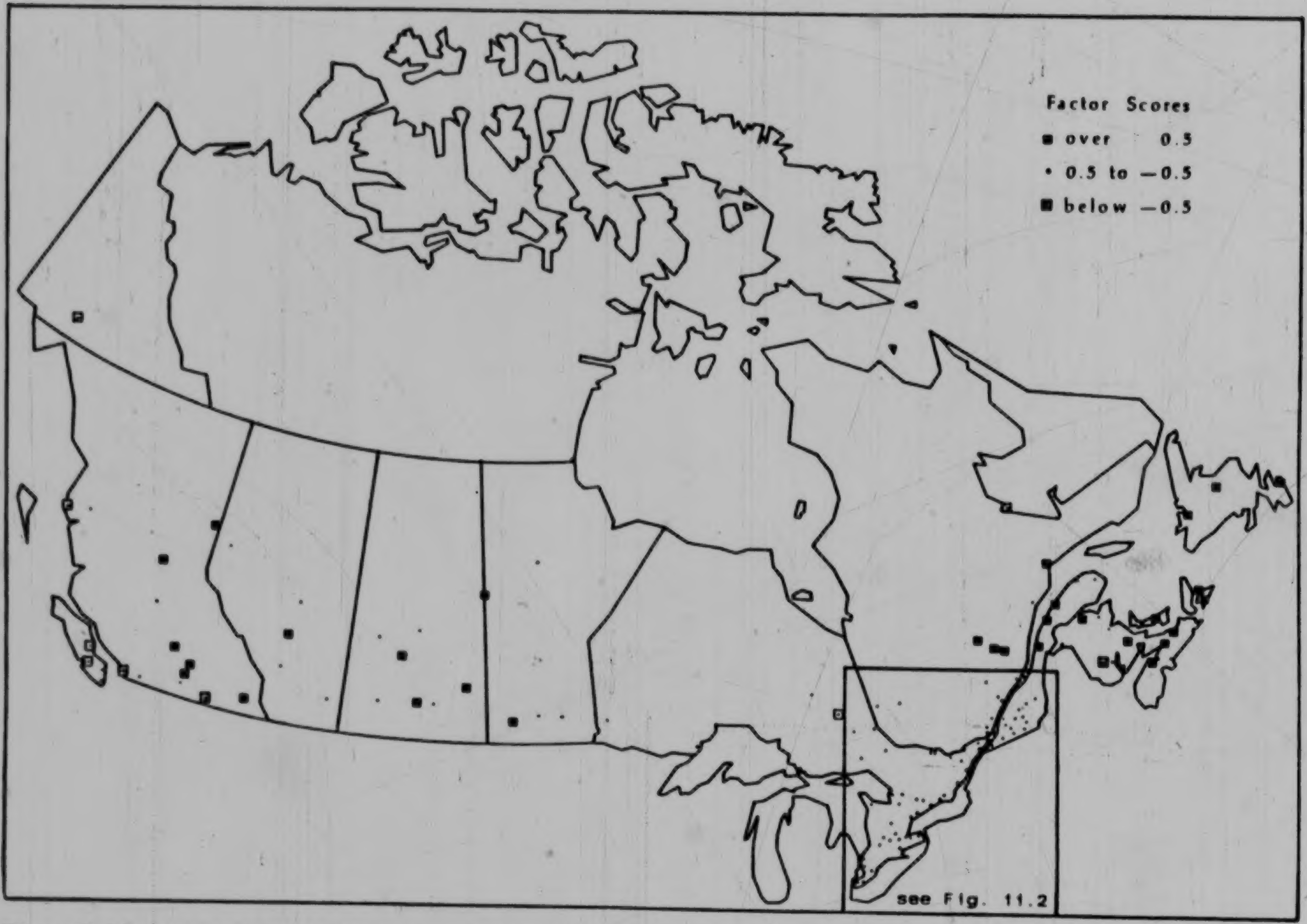

Factor Scores
■ over 0.5
• 0.5 to −0.5
□ below −0.5
see Fig. 11.2

Figure 11.1 Spatial Distribution - the Values of Factor V: 1971

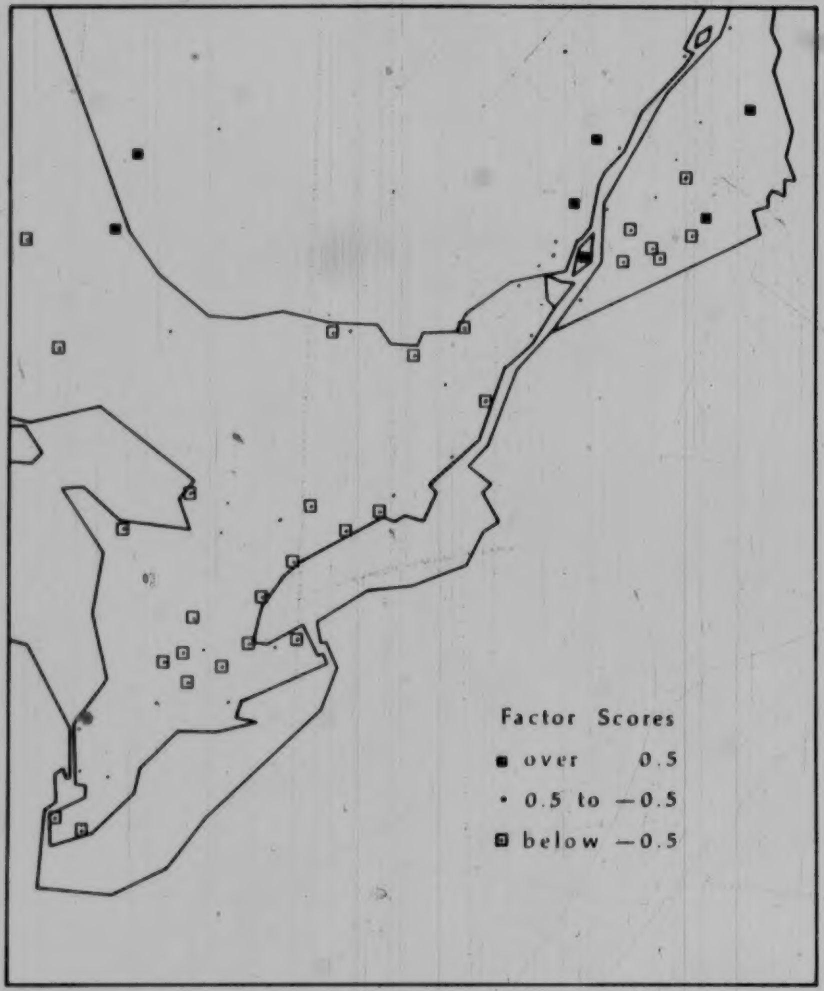

Factor Scores
■ over 0.5
• 0.5 to —0.5
⊡ below —0.5

Figure 11.2 Spatial Distribution - the Values of Factor V: 1971

Table 12. Factor Scores on Factor V. 1971

Score	City	Province	Score	City	Province
2.63	Alma	Q.	-0.51	Asbestos	Q.
2.21	Riviere-du-Loup	Q.	-0.52	Owen Sound	O.
1.82	Rimouski	Q.	-0.54	Peterborough	O.
1.68	Matane	Q.	-0.55	Sudbury	O.
1.58	Edmindston	N.B.	-0.56	Arnprior	O.
1.53	St.Georges	Q.	-0.59	Trail	B.C.
1.45	Sydney Mines	N.S.	-0.63	Hamilton	O.
1.31	Campbellton	N.B.	-0.64	Windsor	O.
1.17	Kelowna	B.C.	-0.64	Medicine Hat	A.
1.15	Dolbeau	Q.	-0.65	Labrador City	Nfld.
1.07	Vernon	B.C.	-0.66	Cowansville	Q.
1.06	Sydney	N.S.	-0.69	Granby	Q.
1.05	Grand Falls	Nfld.	-0.70	Guelph	O.
1.02	Rouyn	Q.	-0.74	Woodstock	O.
1.01	Dawson Creek	B.C.	-0.75	Cobourg	O.
1.00	Joliette	Q.	-0.78	Oshawa	O.
0.99	Kentville	N.S.	-0.82	Brockville	O.
0.94	Haileybury	O.	-0.82	St.Jean	Q.
0.92	Corner Brook	Nfld.	-0.89	Prince Rupert	B.C.
0.89	St.Hyacinthe	Q.	-0.91	St.Catharines-Niagara	O.
0.87	Kamloops	B.C.	-0.93	Ottawa-Hull	O.-Q.
0.86	Chicoutimi-Jonquiere	Q.	-1.01	Montreal	Q.
0.82	Cranbrook	B.C.	-1.05	Magog	Q.
0.82	New Glasgow	N.S.	-1.13	New Hamburg	O.
0.82	Sherbrooke	Q.	-1.15	Brantford	O.
0.80	Trois-Rivieres	Q.	-1.21	Summerside	P.E.I.
0.68	Flin Flon	M.-S.	-1.22	Port Alberni	B.C.
0.67	St.John's	Nfld.	-1.31	Summerside	B.C.
0.66	Red Deer	A.	-1.34	Wallaceburg	O.
0.64	Moncton	N.B.	-1.40	Stratford	O.
0.64	Brandon	M.	-1.49	Toronto	O.
0.63	Shawinigan	Q.	-1.72	Kitchener	O.
0.60	Saskatoon	S.	-2.42	Trenton	O.
0.59	Moose Jaw	S.	-3.77	Petawawa	O.
0.56	Sept-Iles	Q.	-5.02	Oromocto	N.B.

The high loadings on occupations in the natural sciences (R16, 22.1%) and managerial and administrative occupations (R15, 13.7%), suggest the white-collar service type of employment profile, analogous to the first dimension. However, loading on the population size variable (POP1, 18.5%) stresses the association of the sixth dimension with the large metropolitan centers. This dimension indexes the metropolitan type of economic profile present mostly in the larger cities and associated with the high levels of unemployment. The cities with the highest and the lowest loadings on this dimension are listed in Table 13. Once again, similarly to the first dimension, almost all metropolitan centers of the Canadian urban system rank high on this scale. The remaining cities are the medium and small size service centers located in all geographical regions of Canada (Figure 12.1 and 12.2).

The spatial interpretation of the fifth and sixth dimension represented as vertical and horizontal axes on Figure 19. is very difficult. There are no clusters of cities according to their location by provinces. The only distinct pattern is formed by the cities located in Ontario, which tend to group in the third and fourth quadrants of the diagram. This location in two dimensional space indicates that all cities in Ontario except six have negative scores on the fifth dimension (service centers outside metropolitan areas with high male unemployment), indexing the negative association of these cities with the fifth dimension.

The fifth and sixth dimensions account together for 13.3% of the total variance in the 1971 data matrix. However, the combinations of the variables yielded on these dimensions are difficult to interpret. The fifth dimension is similar to the third one and the sixth to the first one. Such a structure can be interpreted as being the result of the redundance of the cumulative information (explanation) accounted for on these dimensions. This configuration implies that the most important dimensions underlying the economic structure of the Canadian urban system in 1971 has been sufficiently aggregated by the first four dimensions.

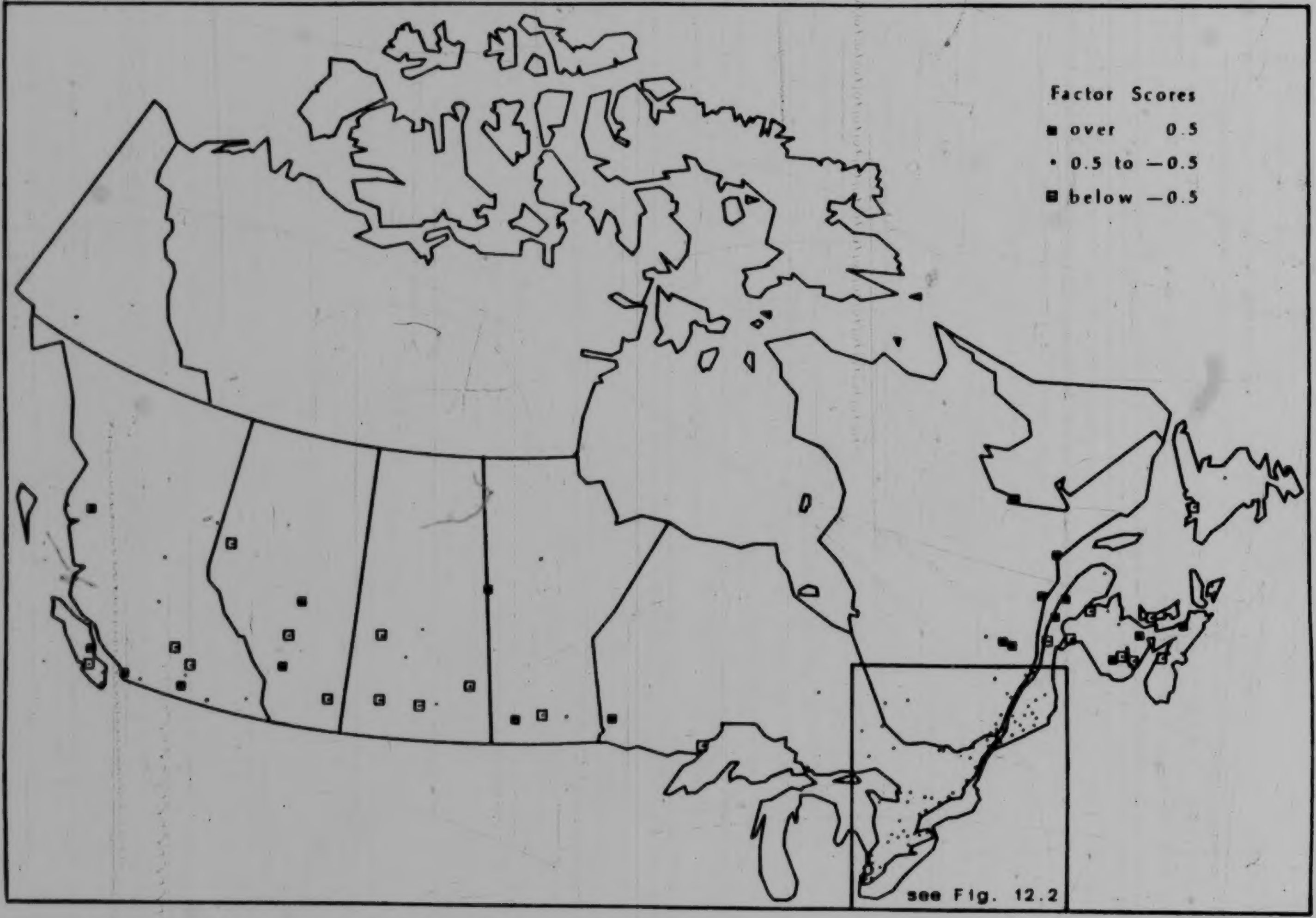

Factor Scores
■ over 0.5
• 0.5 to −0.5
▣ below −0.5
see Fig. 12.2

Figure 12.1 Spatial Distribution - the Values of Factor VI: 1971

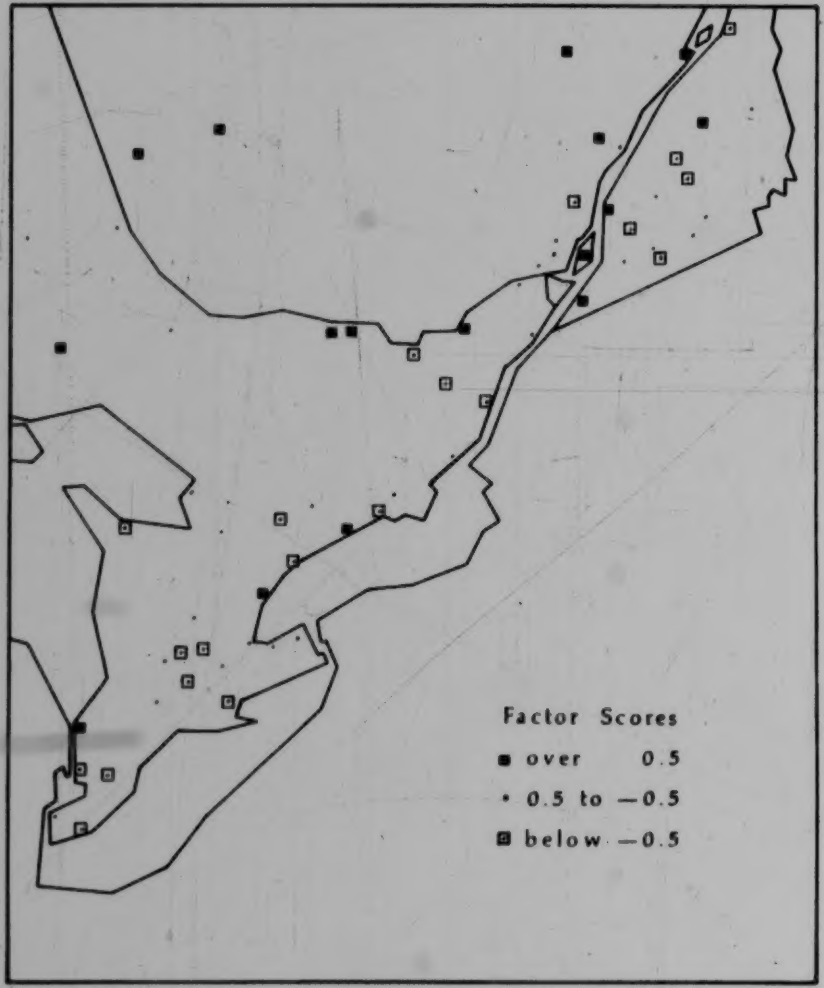
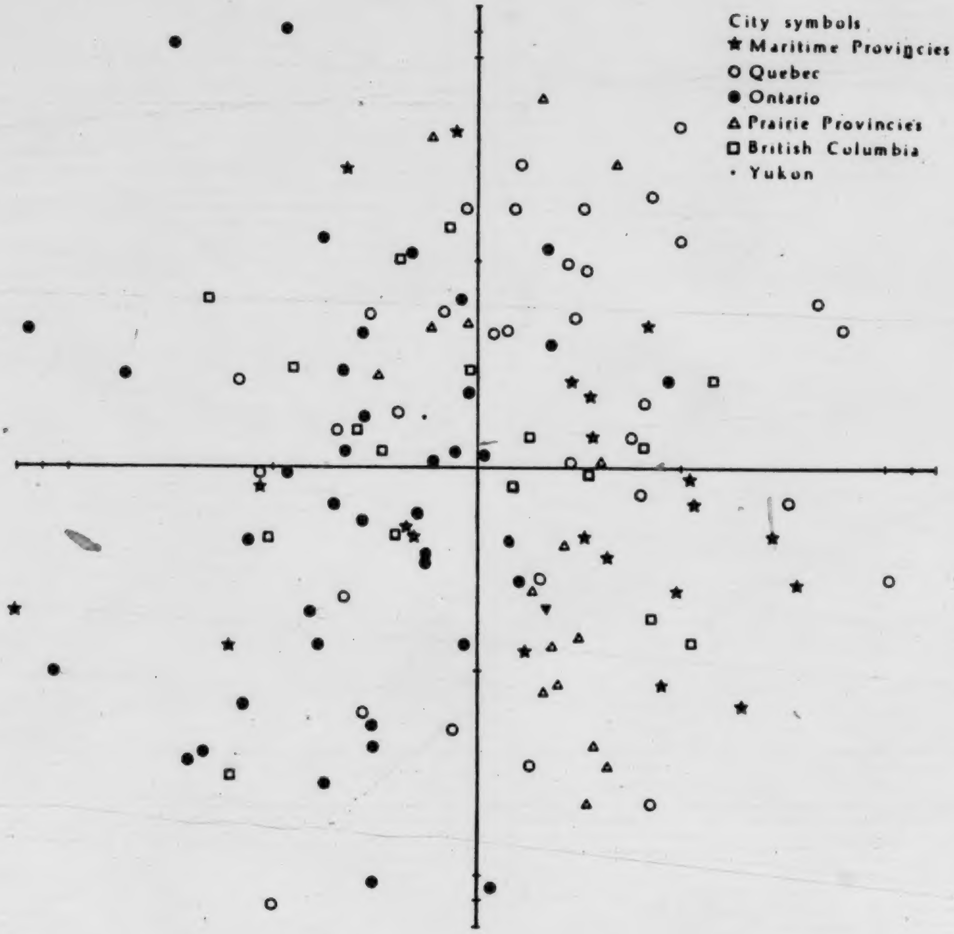

Factor Scores
■ over 0.5
• 0.5 to —0.5
▣ below —0.5

Figure 12.2 Spatial Distribution - the Values of Factor VI : 1971

Table 13. Factor Scores on Factor VI. 1971

Score	City	Province	Score	City	Province
3.22	Cowansville	Q.	-0.64	Cornwall	O.
3.09	Monteral	Q.	-0.66	North Battleford	S.
2.60	Toronto	O.	-0.70	Brockville	O.
2.13	Alma	Q.	-0.70	Oromocto	N.B.
1.67	Rouyn	Q.	-0.74	Kamloops	B.C.
1.66	Calgary	A.	-0.84	Yorkton	S.
1.63	Fredericton	N.B.	-0.87	Oshawa	O.
1.48	Val d'Or	Q.	-0.87	Chatham	O.
1.48	Flin Flon	M.-S.	-0.88	Vernon	B.C.
1.45	Labrador City	Nfld.	-0.88	Swift Current	S.
1.31	Chicoutimi-		-0.89	Summerside	P.E.I.
	-Jonquiere	Q.	-0.91	Saint John	N.B.
1.26	Quebec	Q.	-1.00	Trenton	O.
1.25	Shawinigan	Q.	-1.08	Grande Prairie	A.
1.25	St.Catharines-		-1.09	Corner Brook	Nfld.
	-Niagara	O.	-1.11	Joliette	Q.
1.17	Penticton	B.C.	-1.11	Medicine Hat	A.
1.11	Cobourg	O.	-1.16	Brantford	O.
1.08	Kenora	O.	-1.18	Campbellton	N.B.
1.04	Vancouver	B.C.	-1.21	Arnprior	O.
1.04	Sarnia	O.	-1.27	Owen Sound	O.
0.99	Thetford Mines	Q.	-1.29	Simcoe	O.
0.95	Sept-Iles	Q.	-1.36	Moose Jaw	S.
0.82	Courtenay	B.C.	-1.37	Lindsay	O.
0.81	Pembroke	O.	-1.40	Wallaceburg	O.
0.79	Matane	Q.	-1.44	Stratford	O.
0.75	Lachute	Q.	-1.46	Victoriaville	Q.
0.73	Asbestos	Q.	-1.47	Brandon	M.
0.72	La Tuque	Q.	-1.53	Port Alberni	B.C.
0.70	Edmonton	A.	-1.56	Woodstock	O.
0.69	New Glasgow	N.S.	-1.64	Red Deer	A.
0.69	Regina	S.	-1.65	St.Hyacinthe	Q.
0.68	Baie-Comeau	Q.	-1.80	Portage la Prairie	M.
0.68	Rimouski	Q.	-2.12	Smiths Falls	O.
0.67	Petawawa	O.	-2.18	Leamington	O.
0.66	Valleyfield	Q.			
0.64	Sudbury	O.			

Figure 13. Two Factor Space: Factor V and VI: 1971



4.5 Economic Dimensions of the Canadian Urban System in 1971

The first six factors generated from the original data matrix account for 64.2% of the total variance in the 1971 data matrix. An examination of these loadings, supported by their respective factor scores and diagrams, allowed for fairly detailed interpretation to be given to the first four factors. For the remaining two factors, no clear interpretation could be achieved due to the redundancy of the explanation accounted for by the variables loaded on these dimensions.

In 1971 the major economic dimensions of the Canadian urban system were identified as:

1. White-collar, service-administrative character of metropolitan centers of Canada.
2. High female employment in manufacturing and low unemployment in secondary sector.
3. Frontier-service centers.
4. Specialized manufacturing centers.

The complex inter-relationships associated with this system have been explained by the first four dimensions, which account together for 50.8% of the total explanation. The remaining two dimensions, which account for 13.3% of the total explanation, are combinations of the previous four, therefore, are not significant and are not included in any further analysis.

This structure of the Canadian economic dimensions implies that the remaining part of the unexplained variance is due to the factors which are not taken into account in the data matrix. Therefore, the variables selected for the analysis in this thesis, that is, the demographic, labor force and employment variables can account for only about half of the total variance (50.8% explained by the first four dimensions in 1981) in the data matrix. Perhaps, the only method of improving the adequacy of the total solution is to include in the analysis variables indicating the socio-political diversification of the Canadian urban system. However, these aspects of the spatial diversification of the Canadian cities are beyond the scope of this thesis.

The following chapter is a detailed interpretation of the economic dimensions of the Canadian urban system in 1981. The areal distribution of the cities in 1981 most clearly associated with the respective dimensions will be compared with the results of 1971. A more detailed discussion of the economic changes within the Canadian urban system between 1971 and 1981 will be provided in the fifth chapter of the thesis.

4.6 Interpretation of the Factor Matrix 1981

The 1981 data matrix has been factored using the same procedure as in the previous analysis for 1971 data. Analogically, six factors have been used for the further analysis since at the seventh the contribution of the factor to the total solution drops below 5%.

The first six factors in 1981 account for slightly less of the total variation 62.8% as compared to 1971 - 64.2%. The degree to which the variation in the individual variables has been subsumed by the first six components is given in Table 9. The variable which is least adequately accounted for in the principal-component analysis, on all of the six dimensions, is the craft occupations (R32), which contributes only 13.0% to the total solution. It does not load significantly on any of the six factors. There are six other variables which account for less than 50% of the total variation in the data matrix. They are: total population (POP1, 39.5%), occupations in social sciences (R17, 39.5%), occupations in religious services (R18, 35.5%), primary employment (R25, 43.6%), transport equipment operating occupations (R30, 36.1%) and material handling occupations (R31, 43.9%). The variables most strongly correlated with the dimensions yielded are: secondary employment (R33, 88.1%), female unemployment rate (F10, 83.9%), tertiary employment (R34, 80.5%) and the female participation ratio (F9, 80.2%).

The results of the 1981 analysis are similar to a certain extent to those of 1971. At least four of the least adequately accounted for variables from the 1971 analysis are the same in the 1981 analysis. The same observation can be noted for the most strongly correlated variables in both analyses. The strongest correlation in 1981 is associated with secondary employment. Also tertiary employment emerges in both analyses as one of the strongest loadings. However, the remaining two best cummulative percentages of the total explanation in 1981 are related to the

Table 14. Factor Matrix 1981

Code	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Adequacy
POP1	0.38	-0.11	0.28	-0.11	0.35	0.16	39.5
CH2	0.28	0.09	-0.18	0.59	-0.12	0.21	52.5
M4	0.38	0.68	-0.31	-0.14	0.18	-0.01	75.5
M5	-0.39	-0.68	0.08	0.19	0.35	-0.03	78.0
F9	0.69	0.53	-0.06	0.004	-0.04	-0.20	80.2
F10	-0.63	-0.52	-0.02	-0.07	0.39	0.12	83.9
R14	-0.61	0.02	-0.44	-0.25	0.29	0.25	77.5
R15	0.79	0.001	0.06	0.29	0.21	-0.02	75.6
R16	0.48	0.26	-0.01	-0.11	0.55	-0.10	62.3
R17	0.35	-0.21	0.14	-0.07	-0.10	-0.44	39.5
R18	-0.03	-0.44	0.24	0.20	0.001	-0.25	35.5
R19	0.003	-0.58	0.18	0.09	0.38	-0.05	52.4
R20	0.15	-0.55	0.21	0.08	-0.45	-0.31	67.4
R21	0.22	-0.07	0.34	0.10	0.07	0.60	77.7
R22	0.73	-0.03	0.20	-0.08	0.44	-0.06	77.7
R23	0.33	-0.12	0.29	0.54	-0.17	0.47	74.9
R24	0.08	-0.22	-0.37	-0.71	-0.28	0.32	87.7
R25	-0.32	0.09	-0.52	0.20	-0.12	-0.02	43.6
R26	-0.76	0.07	0.14	0.02	0.19	-0.16	66.4
R27	-0.24	0.50	0.60	-0.006	-0.10	0.08	68.4
R28	-0.39	0.36	0.59	-0.02	-0.04	0.07	63.7
R29	0.002	0.09	-0.63	0.50	0.11	0.02	66.7
R30	0.01	-0.01	-0.46	0.29	0.19	-0.17	36.1
R31	-0.34	0.50	0.13	0.14	0.09	-0.17	43.9
R32	0.10	0.08	0.20	-0.21	0.10	-0.14	13.0
R33	-0.76	0.46	0.23	0.12	0.15	-0.04	88.1
R34	0.75	-0.39	-0.01	-0.28	0.04	0.10	80.5
Eigen	5.65	3.54	2.68	1.99	1.70	1.37	
% of var.	20.9%	13.1%	9.9%	7.4%	6.3%	5.1%	
Cum. %	20.9%	34.0%	44.0%	51.4%	57.7%	62.8%	

Adequacy: the degree to which the variation in the individual variables has been subsumed by the six factors.

% of var.: the sum of the squared factor loadings.

Cum. % : The proportion of the total variation summarized by the factors.

female participation ratio and the female unemployment rate. Therefore, it can be expected that the main dimensions in the 1981 analysis will be structured around secondary and tertiary employment. The strong correlation with the female participation ratio and the female unemployment rate indicates that in 1981 the remaining percentages of the variance in the data is accounted for by the labor force variables, unlike the 1971 analysis.

All six factors in 1981 consist of positive and negative loadings. Therefore, there is no dimension which accounts for only one type of economic profile. They are mathematical artifacts reflecting the bipolar structure of the economic profiles. In other words, the economic structure of most of the Canadian cities cannot be expressed in terms of just one economic dimension, since all dimensions are combinations of at least two different economic profiles.

4.7 The First and the Second Dimensions in 1981

The metropolitan, white-collar, service-administrative character of the first dimension is reflected in the high positive loadings for managerial, administrative and related occupations (R15, 62.4%), tertiary employment (R34, 56.2%), clerical and related occupations (R22, 53.3%) and the female participation ratio (F9, 47.6%). This dimension, in terms of its positive loadings, is identical to the first one in 1971 and explains exactly the same percentage of the total variation in the data matrix - 20.9%.

The negative loadings on this dimension add weight to the interpretation, since the highest is associated with processing occupations (R26, 57.9%), secondary employment (R33, 57.8%), female unemployment (F10, 39.7%) and the male to female participation ratio (R14, 37.2%). The bipolar nature of the first dimension (Table 15.), identical to that of 1971, reflects the negative correlation between tertiary and secondary sectors of industry. This relation means that as the proportion of the tertiary employment in the economic profile of a city increases, the proportion of secondary employment decreases. An explanation of this employment structure is beyond the objective of this thesis. However, it can be hypothesized that this phenomena is due to the relative access of the Canadian market to other markets of

Table 15. Summary of Factor Loadings 1981

Factor I			Factor II			Factor III			Factor IV			Factor V			Factor VI		
Name	Load.	% Exp.	Name	Load.	% Exp.	Name	Load.	% Exp.	Name	Load.	% Exp.	Name	Load.	% Exp.	Name	Load.	% Exp.
R15	0.79	62.40	M4	0.68	46.2	R27	0.60	36.0	CH2	0.59	34.8	R16	0.55	30.2	R21	0.60	36.0
R34	0.75	56.2	F9	0.53	28.1	R28	0.59	34.8	R23	0.54	29.2	R22	0.44	19.4	R23	0.47	22.1
R22	0.73	53.3	R27	0.50	25.0	R21	0.34	11.6	R29	0.50	25.0	F10	0.39	15.2	R24	0.32	10.2
F9	0.69	47.6	R31	0.50	24.9	R23	0.29	8.4	R15	0.29	8.4	R19	0.39	15.1	R14	0.25	6.2
R16	0.48	23.0	R33	0.46	21.2	POP1	0.28	7.8	R30	0.29	8.30	M5	0.35	12.2	CH2	0.21	4.4
POP1	0.38	14.4	R28	0.36	13.0	R18	0.24	5.8	R18	0.20	4.0	POP1	0.35	12.1	POP1	0.16	2.6
M4	0.38	14.3	R16	0.26	6.8	R33	0.23	5.3	R25	0.20	3.9	R14	0.29	8.4	F10	0.12	1.4
R17	0.35	12.2	POP1	0.11	1.2	R20	0.21	4.4	M5	0.19	3.6	R15	0.21	4.4	R34	0.10	0.01
R23	0.33	10.9	CH2	0.09	0.01	R32	0.20	4.0	R31	0.14	2.0	R26	0.19	3.6	R27	0.08	0.01
CH2	0.28	7.8	R25	0.09	0.01	R22	0.20	3.9	R33	0.12	1.4	R30	0.19	3.5	R28	0.07	0.0
R21	0.22	4.8	R29	0.08	0.01	R19	0.18	3.2	R21	0.10	0.01	M4	0.18	3.2	R29	0.02	0.0
R20	0.15	2.2	R32	0.08	0.01	R26	0.14	2.0	R19	0.09	0.01	R33	0.15	2.2	M4	-0.01	0.0
R32	0.10	0.01	R26	0.07	0.01	R17	0.14	1.9	R20	0.08	0.01	R29	0.11	1.2	R15	-0.02	0.0
R24	0.08	0.01	R14	0.02	0.0	R31	0.13	1.7	R26	0.02	0.0	R32	0.10	0.01	R25	-0.02	0.0
R30	0.01	0.0	R15	0.001	0.0	M5	0.08	0.01	F9	0.004	0.0	R31	0.09	0.01	M5	-0.03	0.0
R19	0.004	0.0	R30	-0.01	0.0	R15	0.05	0.0	R27	-0.01	0.0	R21	0.07	0.0	R33	-0.04	0.0
R29	0.002	0.0	R22	-0.03	0.0	R16	-0.01	0.0	R28	-0.02	0.0	R34	0.04	0.0	R19	-0.05	0.0
R18	-0.03	0.0	R21	-0.07	0.01	R34	-0.01	0.0	R17	-0.07	0.0	R18	0.002	0.0	R22	-0.06	0.0
R27	-0.24	8.5	R23	-0.12	1.4	F10	-0.02	0.0	F10	-0.07	0.0	F9	-0.04	0.0	R16	-0.10	0.01
R25	-0.31	9.6	R17	-0.21	4.4	F9	-0.06	0.0	R22	-0.08	0.01	R28	-0.04	0.0	R32	-0.14	2.0
R31	-0.34	11.6	R24	-0.22	4.8	CH2	-0.18	3.2	R16	-0.11	1.1	R27	-0.10	0.01	R26	-0.16	2.6
R28	-0.39	15.2	R34	-0.39	15.2	M4	-0.31	9.6	POP1	-0.11	1.2	R17	-0.10	0.01	R31	-0.17	2.8
M5	-0.39	15.3	R18	-0.44	9.4	R24	-0.37	13.7	M4	-0.14	2.0	R25	-0.12	1.3	R30	-0.17	2.9
R14	-0.61	37.2	F10	-0.53	28.1	R14	-0.44	19.4	R32	-0.21	4.4	CH2	-0.12	1.4	F9	-0.20	4.0
F10	-0.63	39.7	R20	-0.55	30.2	R30	-0.46	21.2	R14	-0.25	6.2	R23	-0.17	2.9	R18	-0.25	6.2
R33	-0.76	57.8	R19	-0.58	33.6	R25	-0.52	27.0	R34	-0.28	7.8	R24	-0.28	7.8	R20	-0.31	9.6
R26	-0.76	57.9	M5	-0.68	46.2	R29	-0.63	39.7	R24	-0.71	50.4	R20	-0.45	20.2	R17	-0.44	19.4

Name: Name of Variable.

Load.: Loading of Variable.

% Exp.: Percent of Explanation.

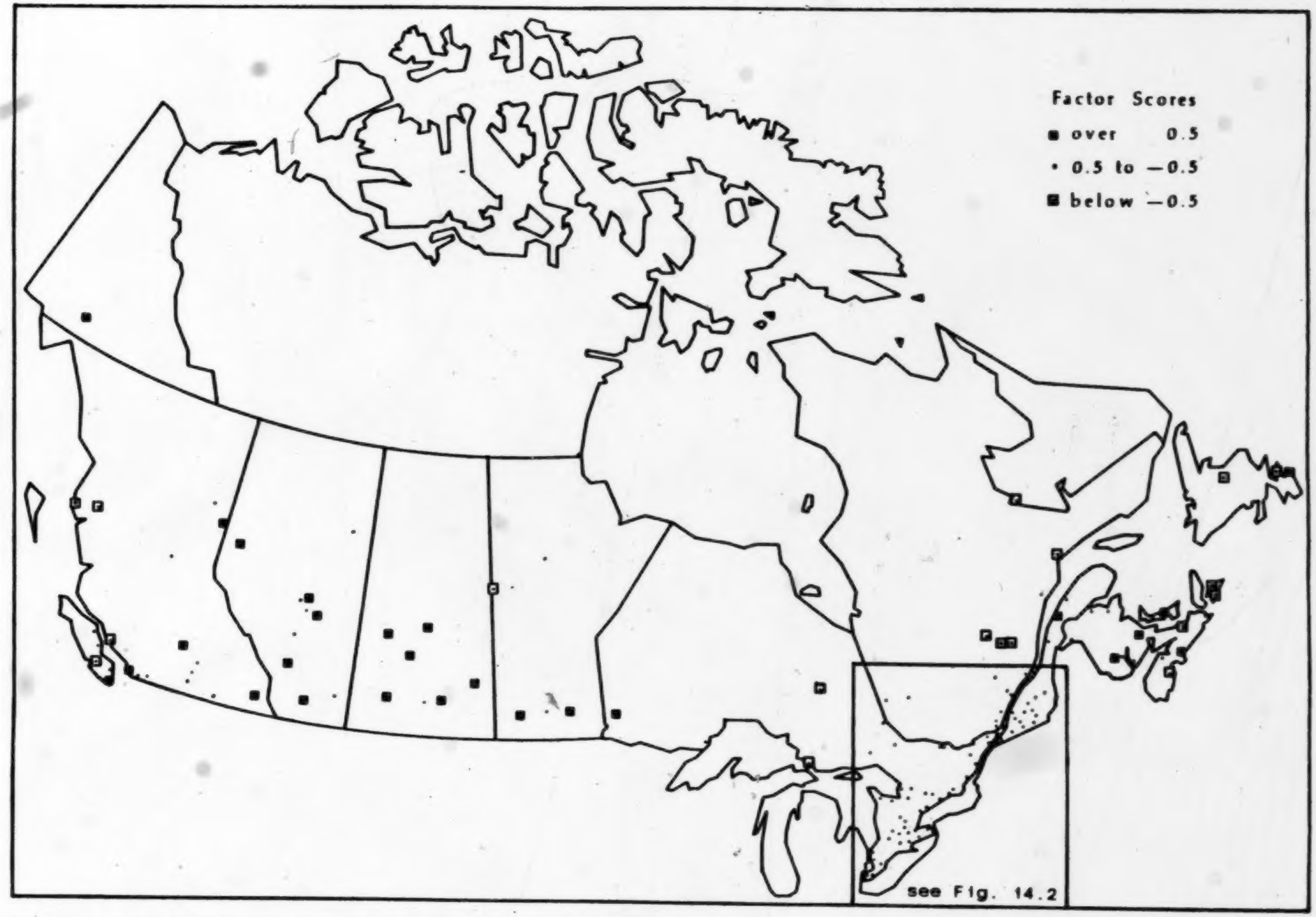
economically developed nations. The secondary employment, particularly manufacturing for the domestic market, is largely maintained by policy, in the form of tariff restrictions which protect the Canadian market. As Simmons (1979, pp.13-14) points out,

> "The small size of the domestic market, the propinquity of the American giant, and an unquestioning lust for foreign capital have brought about a situation in which this domestic manufacturing (indeed many service activities too) is largely carried out by branch plants of American firms."

Cities with the high positive and negative factor scores on the first dimension were plotted on Figures 14.1 and 14.2. In Table 16., the cities with the most significant scores are ranked according to the magnitude of the respective factor scores. Ottawa-Hull scores highest on this scale, as it did in 1971. Once again, of the 35 cities ranked, all are political and administrative centers of the country. Except for four, (compare Table 8. and Table 16.) most of them have changed their relative position on the factor score scale. The detailed analysis of the two scales will be given in Chapter Five where the changes in the Canadian urban system will be analysed.

The second dimension in 1981 explains 13.1% of the total variance extracted from the data matrix. The dimension can be interpreted as indexing those places with high participation ratios both in male and female employment, associated with the manufacturing type of economic profile. The highest loadings on this dimension (Table 15.) are: the male participation ratio (M4, 46.2%), female participation ratio (F9, 28.1%), machinery occupations (R27, 25.0%), material handling occupations (R31, 24.9%) and secondary employment (R33, 21.2%). The negative loadings fully confirm the interpretation of the dimension. The highest negative loadings are: the male unemployment rate (M5, 46.2%), teaching occupations in primary and secondary schools (R19, 33.6%), occupations in medicine and health (R20, 30.2%) and the female unemployment rate (F10, 28.1%).

The reverse correlation between the secondary and the tertiary sector industries resembles strongly the second dimension from the 1971 analysis. However, the second



Factor Scores
■ over 0.5
• 0.5 to −0.5
▣ below −0.5
see Fig. 14.2

Figure 14.1 Spatial Distribution - the Values of Factor I: 1981

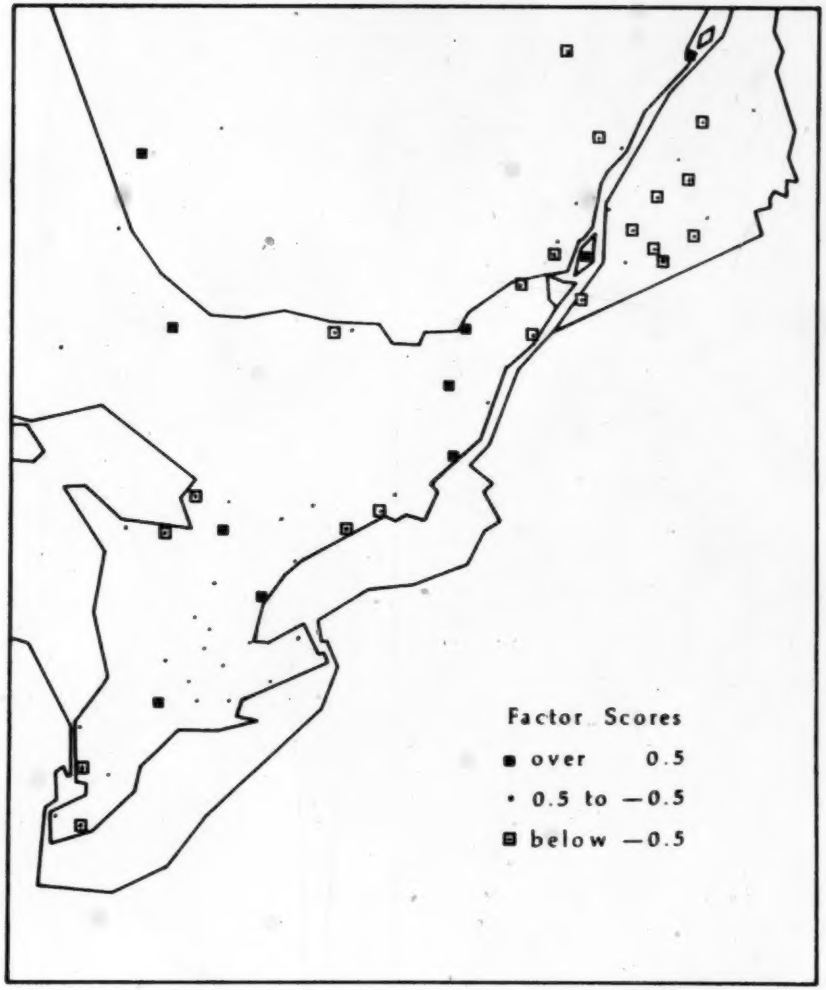

Factor Scores
■ over 0.5
• 0.5 to —0.5
▣ below —0.5

Figure 14.2 Spatial Distribution - the Values of Factor I: 1981

Table 16. Factor Scores on Factor I. 1981

Score	City	Province	Score	City	Province
2.72	Ottawa-Hull	O.Q.	-0.62	Grand Falls	Nfld.
2.38	Calgary	A.	-0.63	Sept-Iles	Q.
2.17	Toronto	O.	-0.67	Trenton	O.
2.02	Whitehorse	Y.	-0.67	Sault Ste.Marie	O.
1.97	Regina	S.	-0.74	Cornwall	O.
1.66	Edmonton	A.	-0.76	Terrace	B.C.
1.63	Halifax	N.S.	-0.78	Thetford Mines	Q.
1.59	Fredericton	N.B.	-0.78	Petawawa	O.
1.52	Saskatoon	S.	-0.79	Kapuskasing	O.
1.51	Vancouver	B.C.	-0.82	Alma	Q.
1.50	Quebec	Q.	-0.84	Collingwood	O.
1.49	Rimouski	Q	-0.92	Drummondville	Q.
1.47	Winnipeg	M.	-0.95	Granby	Q.
1.37	Victoria	B.C.	-1.00	Flin Flon	M.-S.
1.32	Montreal	Q.	-1.02	Prince Rupert	B.C.
1.19	St.John's	Nfld.	-1.03	Cowansville	Q.
1.18	London	O.	-1.06	Midland	O.
1.13	Charlottetown	P.E.I.	-1.08	Leamington	O.
1.08	Grande Prairie	A.	-1.10	Sydney	N.S.
1.07	North Battleford	S.	-1.13	New Glasgow	N.S.
0.98	Lethbridge	A.	-1.18	Valleyfield	Q.
0.93	Yorkton	S.	-1.25	Magog	Q.
0.82	Swift Current	S.	-1.44	Lachute	Q.
0.79	Kingston	O.	-1.57	Labrador City	Nfld.
0.78	Moncton	N.B.	-1.57	Wallaceburg	O.
0.72	Prince Albert	S.	-1.58	Dolbeau	Q.
0.69	Dawson Creek	B.C.	-1.59	Sorel	Q.
0.66	Cranbrook	B.C.	-1.63	Shawinigan	Q.
0.66	North Bay	O.	-1.63	La Tuque	Q.
0.62	Camrose	A.	-1.68	Hawkesbury	O.-Q.
0.62	Barrie	O.	-1.78	Sydney Mines	N.S.
0.60	Kamloops	B.C.	-1.91	Port Alberni	B.C.
0.56	Kenora	O.	-1.94	Powell River	B.C.
0.53	Rouyn	Q.	-2.24	Asbestos	Q.
0.51	Smiths Falls	O.	-2.30	Lunenburg	N.S.
0.51	Brandon	M.	-2.51	Carbonear	Nfld.

dimension in 1981 is much more strongly correlated with the participation ratio indicating a structural change in the employment levels within the system of cities towards a more uniform distribution of the secondary and tertiary sectors among all Canadian cities (compare p.31).

Table 17. lists cities ranked according to their factor scores on the second dimension resulting from the 1981 analysis. The respective areal distribution is shown on Figures 16.1 and 16.2. The highest factor scores are associated with the cities of Southern Ontario (eg.Kitchener, Oshawa), British Columbia (eg. Terrace, Port Alberni) and Alberta (eg. Grande Prairie, Edmonton), while the lowest with the Maritime Provinces (eg. Campbell, Grand Falls) and Quebec (eg. Matane, Dolbeau). The general pattern of areal distribution is similar to that of 1971. As was the case for 1971, the highest ranked city is located in British Columbia i.e. Terrace. Also over one half of the highest ranked cities on the dimension are located in industrial heartland of Southern Ontario analogously to 1971. Such a pattern suggests relatively low dynamics of change in the spatial distribution of the second dimension between 1971 and 1981.

The interpretation of the first two dimensions is facilitated by the diagram shown on Figure 16. The resulting pattern of urban places by provinces is similar to that shown on Figure 7. for 1971. On neither the first nor the second dimension is there any clear grouping of the cities according to the provincial location. The only distinct pattern occurs in the third quadrant of Figure 16., where cities of Quebec cluster together. This location on the diagram means that cities in this province have negative factor scores on both dimensions; therefore, they are reversely associated with the white-collar, service employment, indexed by the second. The opposite observation can be noted for cities of Ontario which are located in most cases (except six) in the remaining three quadrants of the Figure. The scores on the first and the second dimension show the contrast between the cities in Quebec at the lower end of the factor scale (the third quadrant) and the cities of Ontario (Figure 16.).

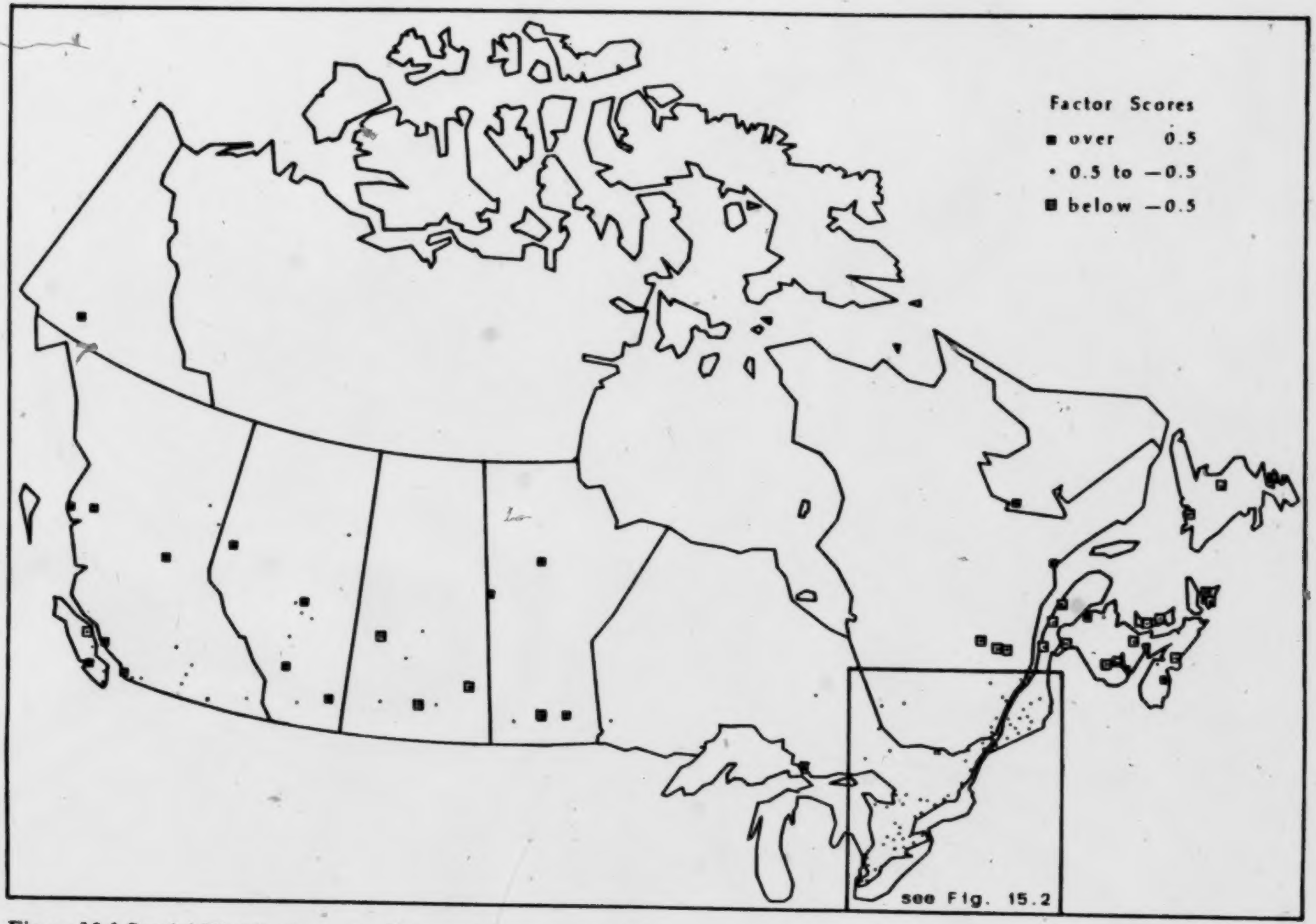

Factor Scores
■ over 0.5
• 0.5 to −0.5
▣ below −0.5
see Fig. 15.2

Figure 15.1 Spatial Distribution - the Values of Factor II : 1981

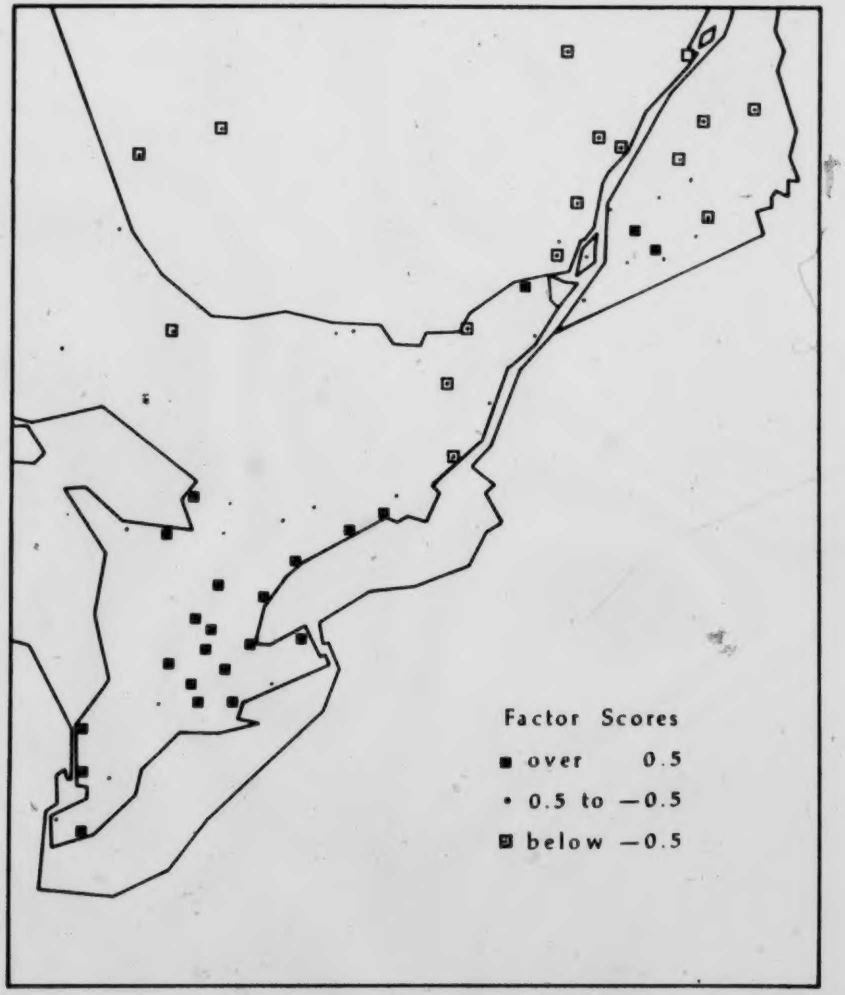
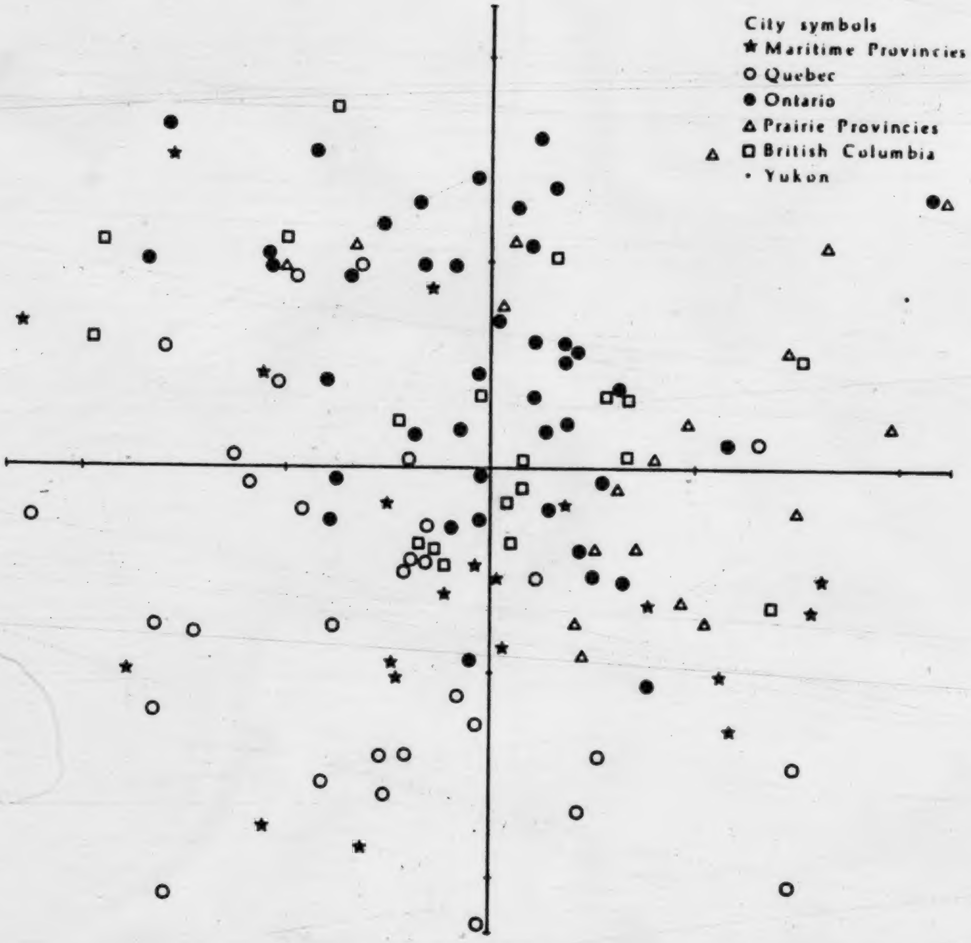

Factor Scores
■ over 0.5
• 0.5 to —0.5
▣ below —0.5

Figure 15.2 Spatial Distribution - the Values of Factor II : 1981

Table 17. Factor Scores on Factor II. 1981

Score	City	Province	Score	City	Province
1.77	Terrace	B.C.	-0.65	Summerside	P.E.I.
1.69	Wallaceburg	O.	-0.68	Victoria	B.C.
1.61	Kitchener	O.	-0.69	Moncton	N.B.
1.55	Labrador City	Nfld.	-0.73	Fredericton	N.B.
1.54	Collingwood	O.	-0.77	North Battleford	S.
1.54	Grande Prairie	A.	-0.77	Portage la Prairie	M.
1.42	Stratford	O.	-0.79	La Tuque	Q.
1.40	Calgary	A.	-0.79	Thetford Mines	Q.
1.36	Orangeville	O.	-0.82	Lachute	Q.
1.31	Toronto	O.	-0.87	Bathurst	N.B.
1.29	Brantford	O.	-0.93	Moose Jaw	S.
1.26	Oshawa	O.	-0.94	Haileybury	O.
1.20	Cobourg	O.	-0.98	Edmundston	N.B.
1.15	Port Alberni	B.C.	-1.01	Sydney Mines	N.S.
1.14	Prince Rupert	B.C.	-1.02	Charlottetown	P.E.I.
1.12	Thompson	M.	-1.04	Corner Brook	Nfld.
1.09	Sault Ste.Marie	O.	-1.08	Kingston	O.
1.08	Edmonton	A.	-1.11	Joliette	Q.
1.08	Hamilton	O.	-1.20	Shawinigan	Q.
1.04	Leamington	O.	-1.26	St.Georges	Q.
1.03	Midland	O.	-1.30	St.John's	Nfld.
1.02	Hawkesbury	O.-Q.	-1.41	Rouyn	Q.
1.01	Prince George	B.C.	-1.42	Trois-Rivieres	Q.
0.99	Sarnia	O.	-1.47	Quebec	Q.
0.99	Woodstock	O.	-1.55	Alma	Q.
0.98	Sept-Iles	Q.	-1.62	Sydney	N.S.
0.98	Trenton	O.	-1.63	Chicoutimi--Jonquiere	Q.
0.98	Flin Flon	M.-S.			
0.94	Granby	Q.	-1.65	Carbonear	Nfld.
0.89	Campbell River	B.C.	-1.69	Sherbrooke	Q.
0.84	Whitehorse	Y.	-1.88	Grand Falls	Nfld.
0.80	Medicine Hat	A.	-2.05	Rimouski	Q.
0.76	Fergus	O.	-2.09	Dolbeau	Q.
0.71	Lunenburg	N.S.	-2.24	Matane	Q.
0.63	Powell River	B.C.	-2.34	Riviere-du-Loup	Q.
			-2.77	Campbellton	N.B.

Figure 16. Two Factor Space: Factor I and II: 1981



4.8 The Third and the Fourth Dimensions in 1981

The third dimension indexing manufacturing cities accounts for 9.9% of the variance in the 1981 data matrix. The highest loadings are associated with machinery occupations (R27, 36.0%) and product fabrication occupations (R28, 34.8%), indexing urban centers with high manufacturing employment, eg. St.Catharines-Niagara, Brantford, Toronto and Woodstock. The negative loadings on construction occupations (R29, 39.9%) and primary employment (R25, 27.0%), indicate the negative correlation of employment in these sectors with manufacturing employment.

The interpretation of the dimension is confirmed by the plotting of the factor scores on Figures 17.1 and 17.2. All but three cities scoring high on this dimension are located in Southern Quebec and Ontario, indicating concentration of manufacturing activity in the heartland of Canada. The only three cities with high positive scores on this dimension located outside Quebec and Ontario are: Vancouver, Winnipeg and New Glasgow (Table 18.). Two of them, i.e. Vancouver and Winnipeg, are highly diversified metropolitan centers with significant shares of manufacturing employment. New Glasgow has developed steel mills based on its ample coal supply (Simmons & Simmons, 1974). Employment in these factories distinguishes the city from the rest of the cities in the Maritime Provinces.

The third dimension in 1981, indexing manufacturing activities in the Canadian urban system, is quite different from the third dimension in 1971. In 1971 the third dimension indexed service centers of Ontario, Quebec, British Columbia and the Maritime Provinces. These results indicate a shift in the economic structure of the Canadian urban system which will be analyzed in more detail in the next chapter.

The population change associated with sales and construction employment are indexed by the fourth dimension in 1981 (variables CH2, 34.8%, R23, 29.2%, R29, 25.0%). The highest scoring cities on this dimension are located in the Prairie Provinces and Quebec (Figures 18.1,18.2 and Table 19.). The dimension indexes those urban centers with the most significant population changes in 1971-1981 period. The highest scoring cities are those whose economy is

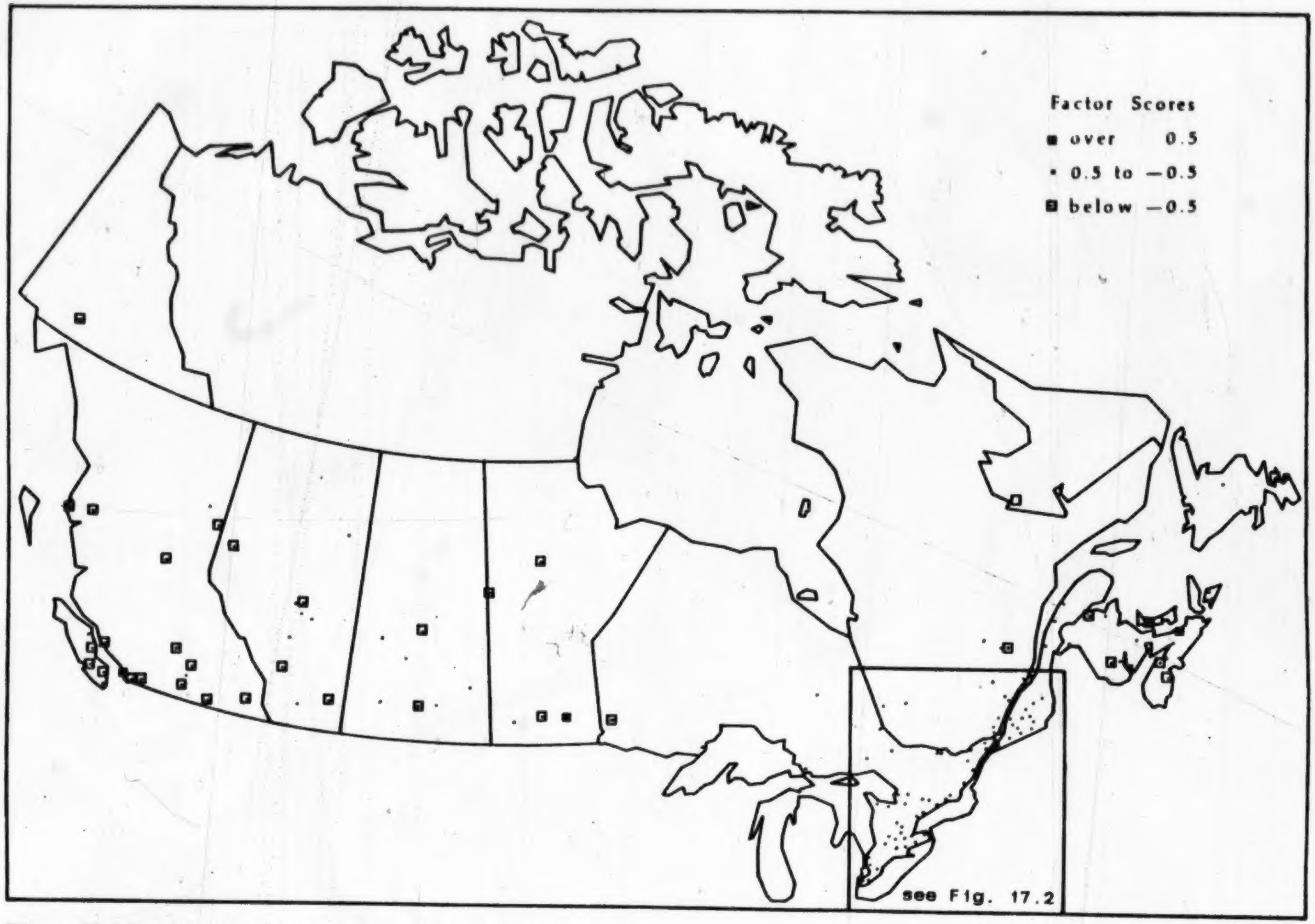

Factor Scores
■ over 0.5
• 0.5 to −0.5
▣ below −0.5
see Fig. 17.2

Figure 17.1 Spatial Distribution - the Values of Factor III : 1981

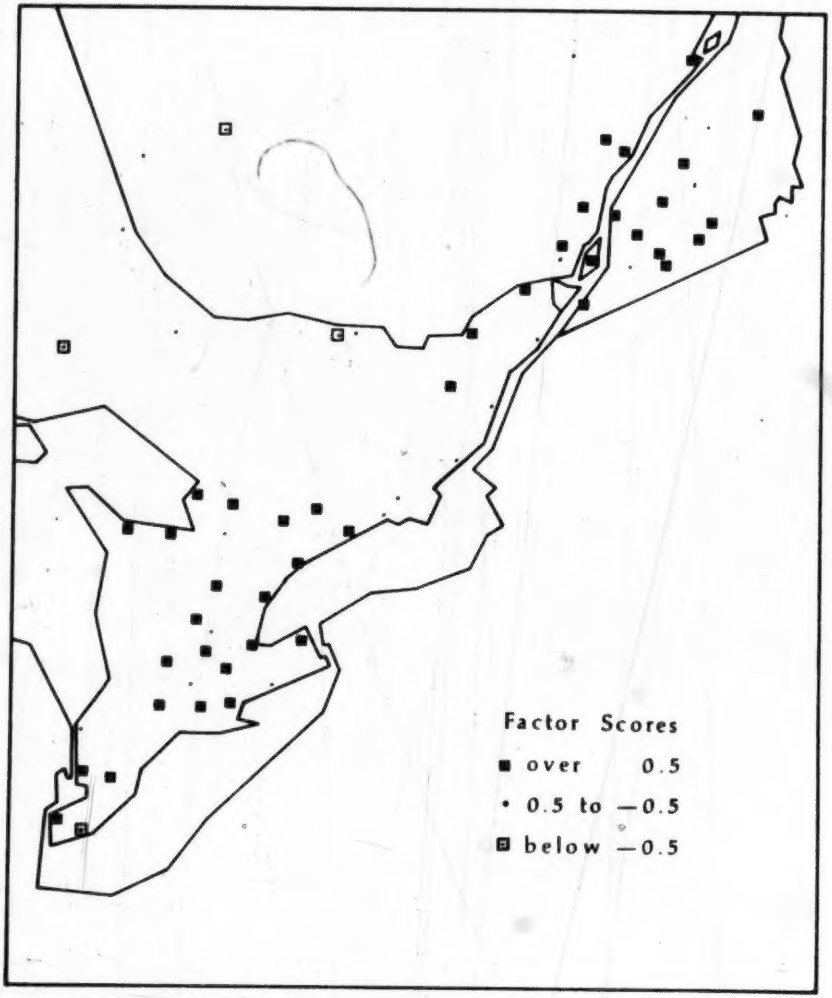

Factor Scores
■ over 0.5
• 0.5 to —0.5
▣ below —0.5

Figure 17.2 Spatial Distribution - the Values of Factor III : 1981

Table 18. Factor Scores on Factor III. 1981

Score	City	Province	Score	City	Province
2.87	St.Catharines-		-0.58	Edmonton	A.
	-Niagara	O.	-0.64	Vernon	B.C.
1.85	Montreal	Q.	-0.67	Sudbury	O.
1.85	Wallaceburg	O.	-0.70	Carbonear	Nfld.
1.82	Brantford	O.	-0.71	Penticton	B.C.
1.81	Stratford	O.	-0.71	Calgary	A.
1.72	Toronto	O.	-0.73	Prince Rupert	B.C.
1.67	Woodstock	O.	-0.81	Prince Albert	S.
1.64	Winnipeg	M.	-0.82	Terrace	B.C.
1.50	Hawkesbury	O.-Q.	-0.84	Dawson City	Y.
1.47	Windsor	O.	-0.91	Kentville	N.S.
1.47	Kitchener	O.	-0.94	Prince George	B.C.
1.46	Midland	O.	-0.97	Summerside	P.E.I.
1.44	St.Hyacinthe	Q.	-1.01	Kenora	O.
1.41	Victoriaville	Q.	-1.01	Nanaimo	B.C.
1.32	Sherbrooke	Q.	-1.04	Val d'Or	Q.
1.29	Guelph	O.	-1.07	Flin Flon	M.-S.
1.23	Drummondville	Q.	-1.11	Labrador City	Nfld.
1.20	Joliette	Q.	-1.11	Kamloops	B.C.
1.17	Trois-Rivieres	Q.	-1.13	Port Alberni	B.C.
1.11	Oshawa	O.	-1.14	Powell River	B.C.
1.10	Fergus	O.	-1.16	Whitehorse	Y.
1.03	Hamilton	O.	-1.20	Lunenburg	N.S.
1.01	Collingwood	O.	-1.20	Moose Jaw	S.
0.99	Sorel	Q.	-1.24	Cranbrook	B.C.
0.96	Magog	Q.	-1.25	Thompson	M.
0.92	Granby	Q.	-1.27	Grande Prairie	A.
0.92	Cowansville	Q.	-1.36	Trail	B.C.
0.89	St.Jerome	Q.	-1.37	Chilliwack	B.C.
0.87	Orillia	O.	-1.52	Medicine Hat	A.
0.84	Peterborough	O.	-1.79	Courtenay	B.C.
0.84	London	O.	-2.00	Abbotsford	B.C.
0.81	Smiths Falls	O.	-2.07	Campbellton	N.B.
0.80	Valleyfield	Q.	-2.14	Oromocto	N.B.
0.78	Cobourg	O.	-2.81	Petawawa	O.
0.74	Lindsay	O.			

based on primary industries sensitive to periodic fluctuations in demand for raw materials, i.e. Abbotsford and Carbonear. These cities are usually characterized by significant changes of in- and out- migration levels which explains the structure of the loadings on the fourth dimension (Blackbourn & Putnam, 1984, p.179).

The highest negative loadings on the fourth dimension are associated with service occupations (R24, 50.4%). This means that cities characterized by high population change ratios and high levels of sales and construction employment have relatively low levels of service occupations. However, such an interpretation is only partially confirmed by the factor scores on the fourth dimension, since among the highest scoring urban places are Edmonton and Calgary, whose economies tend to be much more diversified (see pp. 41-42).

On neither the third nor the fourth dimension is there any clear grouping of cities in terms of their spatial distribution by provinces (Figure 19.). However, the second quadrant of the diagram indicates cities with the most significant share of the manufacturing employment. All of these cities are located in Ontario and Quebec. The cities with the opposite factor scores are grouped in the fourth quadrant of the diagram. Almost all of these are located in the Western and Maritime Provinces. These two extremes indicate that the third and the fourth dimensions in 1981 have determined the division of the Canadian urban system between the industrial heartland and the frontier. The second quadrant of the diagram groups cities with the manufacturing type of employment, while the fourth quadrant groups cities with service type of economic profile, located in the peripheral regions of Canada.

4.9 The Fifth and the Sixth Dimensions in 1981

The fifth and the sixth dimensions in 1981 account together for 9.4% of the total variance in the 1981 data matrix (i.e. the fifth 6.3% and the sixth - 5.1%). Consequently, the aggregate explanation of these dimensions accounts for less of the total variance than the third dimension in 1981 alone. All of the variables emerging on both dimension are components of the previous four. Therefore, the fifth and sixth dimensions in 1981 are combinations of the

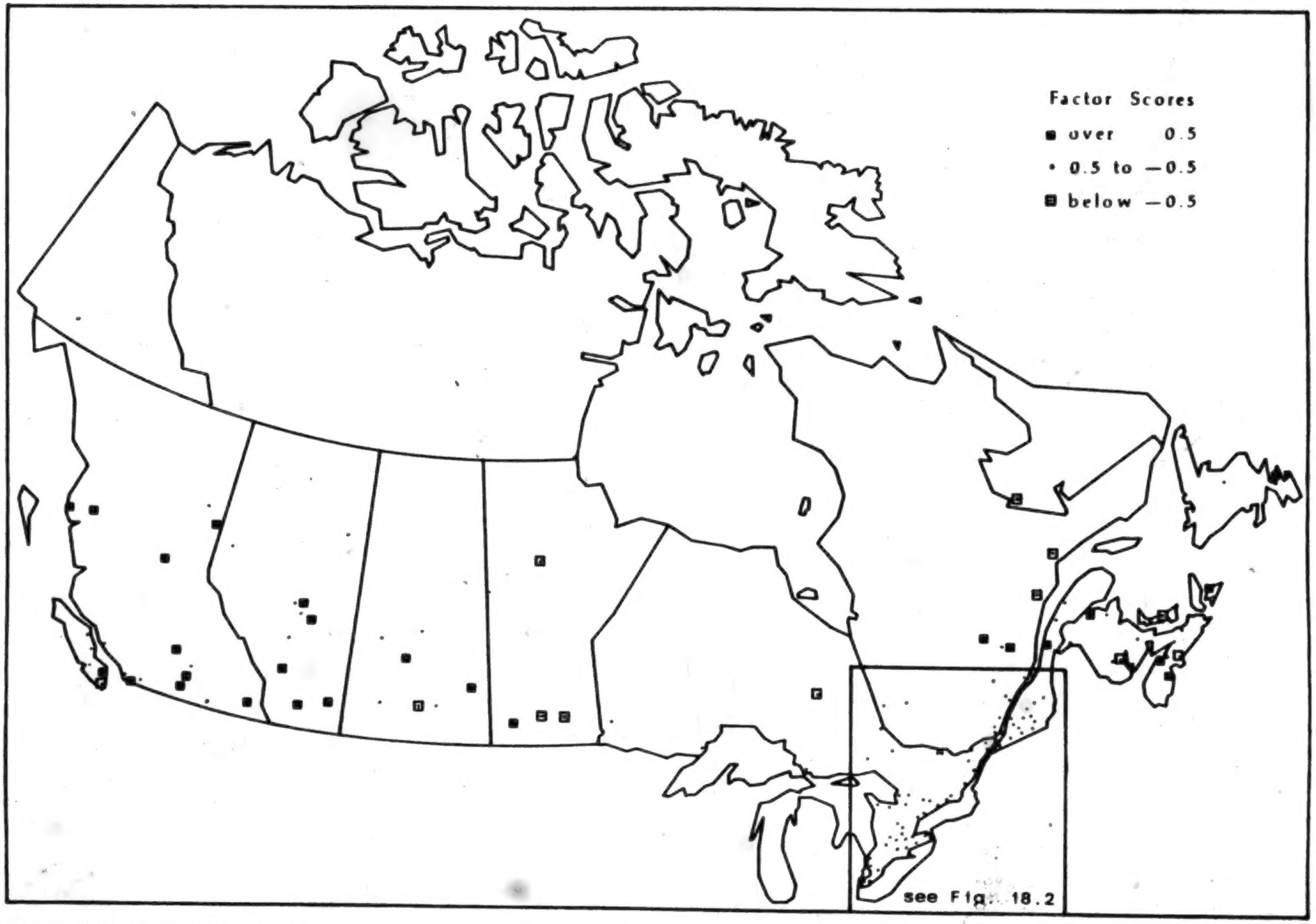

Factor Scores
■ over 0.5
• 0.5 to −0.5
▣ below −0.5
see Fig. 18.2

Figure 18.1 Spatial Distribution - the Values of Factor IV: 1981

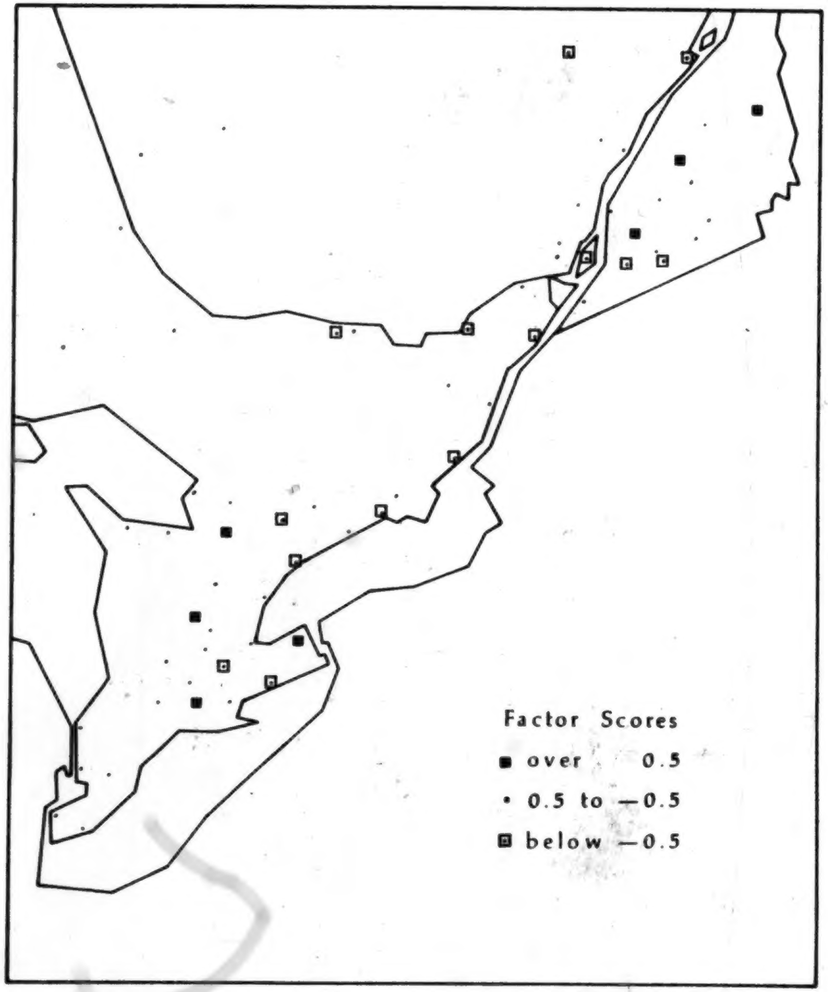
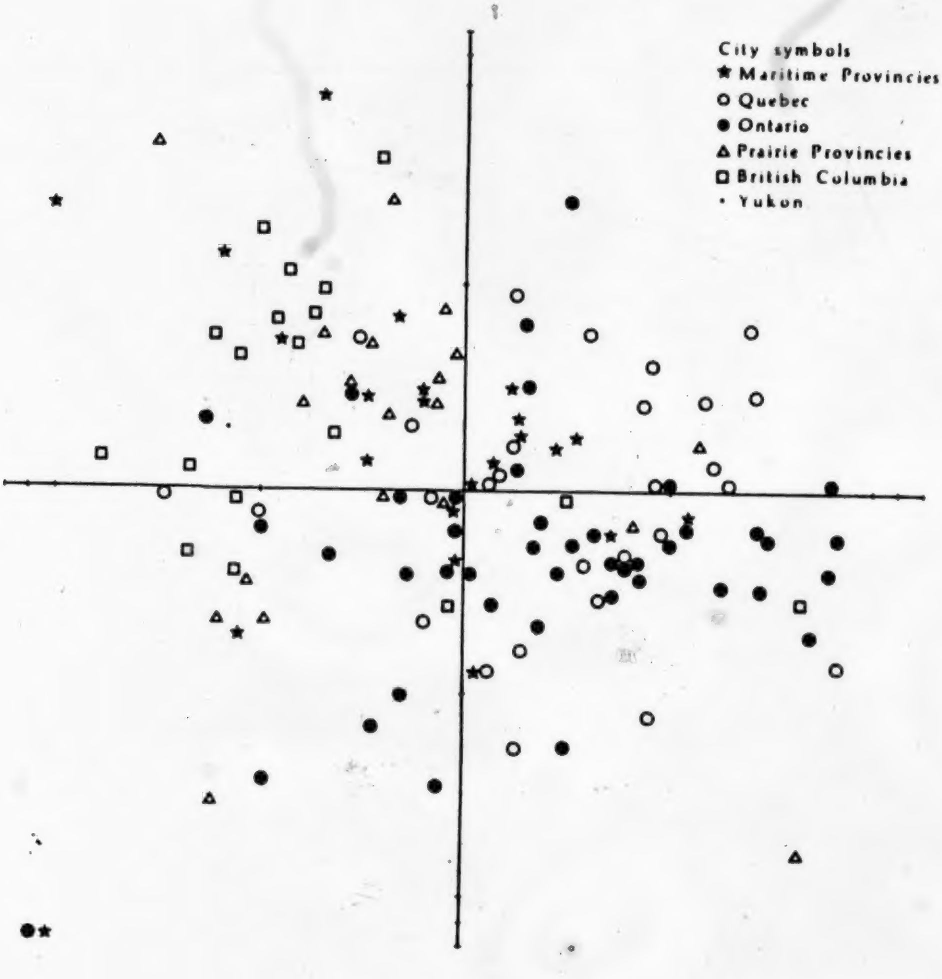

Factor Scores
■ over 0.5
• 0.5 to —0.5
▣ below —0.5

Figure 18.2 Spatial Distribution - the Values of Factor IV: 1981

Table 19. Factor Scores on Factor IV. 1981

Score	City	Province
2.49	Abbotsford	B.C.
1.90	Carbonear	Nfld.
1.69	Medicine Hat	A.
1.64	Chicoutimi-Jonquiere	Q.
1.43	St.Catharines-Niagara	O.
1.43	Camrose	A.
1.41	Tillsonburg	O.
1.38	Campbell River	B.C.
1.26	Nanaimo	B.C.
1.15	Lunenburg	N.S.
1.02	Dawson Creek	B.C.
0.99	Penticton	B.C.
0.96	Riviere-du-Loup	Q.
0.88	Lethbridge	A.
0.86	Prince Rupert	B.C.
0.85	Sydney Mines	N.S.
0.82	Prince George	B.C.
0.82	Barrie	O.
0.80	Victoriaville	Q.
0.77	Calgary	A.
0.77	St.Georges	Q.
0.76	Cranbrook	B.C.
0.75	Chilliwack	B.C.
0.73	Kentville	N.S.
0.72	Terrace	B.C.
0.71	Dolbeau	Q.
0.67	Brandon	M.
0.66	Kamloops	B.C.
0.62	Granby	Q.
0.54	Saskatoon	S.
0.51	Edmonton	A.
0.50	Yorkton	S.
0.50	Orangeville	O.
0.48	Truro	N.S.
0.47	Leamington	O.
-0.40	Port Alberni	B.C.
-0.40	Brockville	O.
-0.42	Sault Ste.Marie	O.
-0.42	Rouyn	Q.
-0.43	Stratford	O.
-0.45	Orillia	O.
-0.46	Flin Flon	M.-S.
-0.47	Guelph	O.
-0.50	Windsor	O.
-0.51	Lindsay	O.
-0.53	Quebec	Q.
-0.56	Woodstock	O.
-0.57	Victoria	B.C.
-0.58	Selkirk	O.
-0.65	Portage la Prairie	M.
-0.66	La Tuque	Q.
-0.67	Cornwall	O.
-0.67	Moose Jaw	S.
-0.72	Labrador City	Nfld.
-0.71	Toronto	O.
-0.79	St.Jean	Q.
-0.86	Montreal	Q.
-0.89	Halifax	N.S.
-0.89	Sept-Iles	Q.
-1.03	Kingston	O.
-1.12	Cowansville	Q.
-1.17	Kapuskasing	O.
-1.28	Ottawa-Hull	O.-Q.
-1.28	Baie-Comeau	Q.
-1.44	Summerside	P.E.I.
-1.45	Trenton	O.
-1.54	Thompson	M.
-1.79	Winnipeg	M.
-5.71	Petawawa	O.
-5.77	Oromocto	N.B.

Figure 19. Two Factor Space: Factor III and IV: 1981



first four. It can be expected that meaningful interpretation of these two dimensions will be difficult.

The fifth dimension loads highly only on one variable, that is, occupations in the natural sciences (R16, 30.2%). The remaining significant loadings are associated with clerical and related occupations (R22, 19.4%), female unemployment (F10, 15.2%), teaching in primary and secondary schools (R19, 15.1%) and the male unemployment rate (M5, 12.2%). The only high negative loading (Table 10.) is associated with occupations in medicine and health (R20, 20.2%).

The dimension appears to index service functions of large metropolitan and medium sized urban centers of Canada. The association of the dimenson with occupations in natural sciences, clerical and teaching occupations suggests the service centers with the high white-collar employment, particularly in the larger cities in Canada. It can be concluded, therefore, that the fifth dimension is an aggregate of the first dimension with high unemployment level indicated by the presence of the high loadings on variable F10 (0.39) and M5 (0.35).

Figures 20.1 and 20.2 show the spatial distribution of the cities associated with the fifth dimension. Most of them are located in Quebec and the Maritime Provinces. Some of the Western cities, particularly the large ones in British Columbia and Alberta, have high scores on this dimension. However, the rest of the cities, in particular in Saskatchewan and Ontario, score negatively on it. Table 20. lists the cities ranked according to their respective factor scores on the fifth dimension. Characteristically, large service cities with diversified functional structures rank high on this scale i.e. Monteral, Toronto, Calgary and Quebec-City, while small service towns like Camrose, Moose Jaw or Tillsonburg rank on the bottom of the scale, showing a much lower degree of the economic diversification.

Another aspect of the service economic structure is reflected in the sixth dimension. The highest score is associated with the artistic-craft occupations (R21, 36.0%), sales occupations (R23, 22.1%) and service occupations (R24, 10.2%). Clearly, the dimension

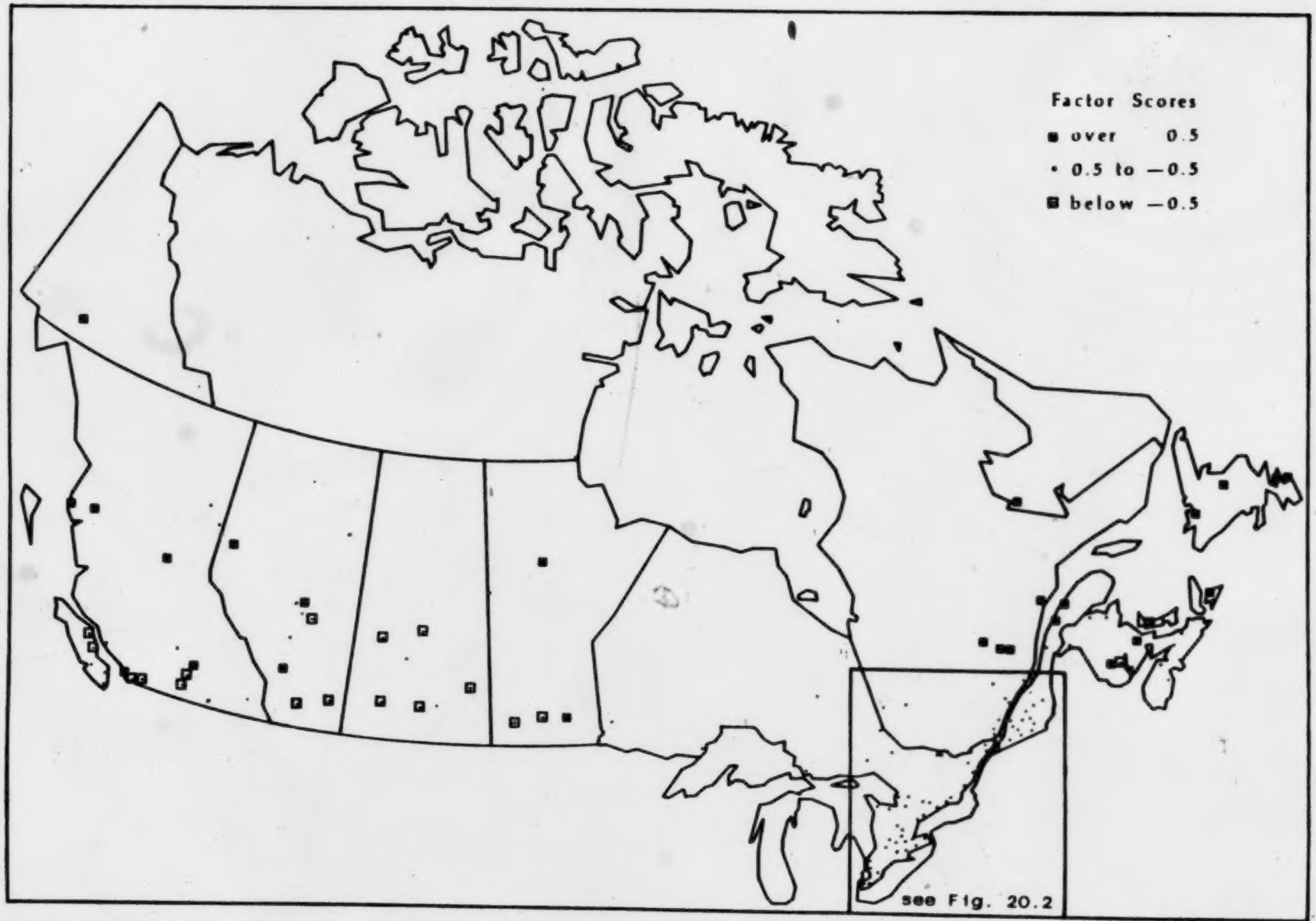

Factor Scores
■ over 0.5
• 0.5 to —0.5
▣ below —0.5
see Fig. 20.2

Figure 20.1 Spatial Distribution - the Values of Factor V: 1981

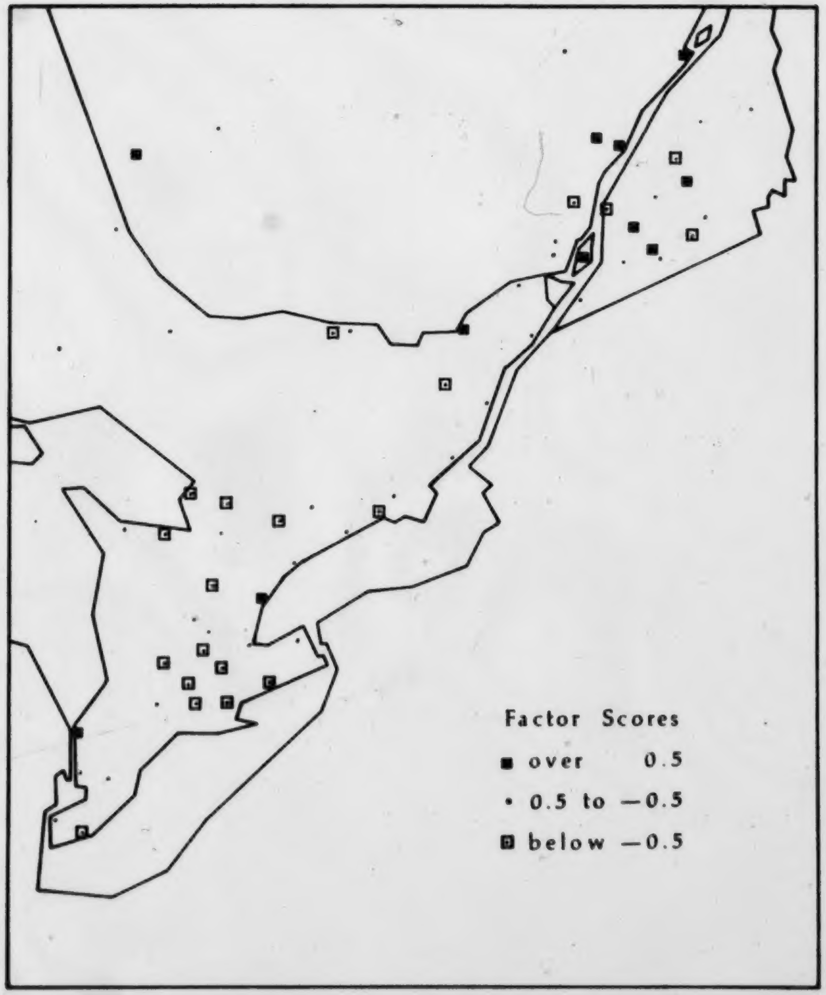

Factor Scores
■ over 0.5
• 0.5 to —0.5
▣ below —0.5

Figure 20.2 Spatial Distribution - the Values of Factor V: 1981

Table 20. Factor Scores on Factor V. 1981

Score	City	Province	Score	City	Province
2.37	Carbonear	Nfld.	-0.64	Petawawa	O.
2.33	Montreal	Q.	-0.65	Lethbridge	A.
2.18	Toronto	O.	-0.68	Magog	Q.
2.15	Labrador City	Nfld.	-0.70	Medicine Hat	A.
2.11	Chicoutimi-		-0.75	St.Hyacinthe	Q.
	-Jonquiere	Q.	-0.75	Courtenay	B.C.
1.95	Baie-Comeau	Q.	-0.77	Brantford	O.
1.85	Terrace	B.C.	-0.77	Kelowna	B.C.
1.70	Ottawa-Hull	O.-Q.	-0.77	Trenton	O.
1.50	Calgary	A.	-0.78	Summerside	P.E.I.
1.40	Alma	Q.	-0.81	Lindsay	O.
1.35	Shawinigan	Q.	-0.84	Woodstock	O.
1.32	Rimouski	Q.	-0.90	Stratford	O.
1.25	Matane	Q.	-0.91	Fergus	O.
1.19	Corner Brook	Nfld.	-1.07	Collingwood	O.
1.17	Quebec	Q.	-1.11	Joliette	Q.
1.12	Sarnia	O.	-1.21	Swift Current	S.
1.11	Whitehorse	Y.	-1.21	Simcoe	O.
1.07	Grand Falls	Nfld.	-1.27	Leamington	O.
1.05	Fredericton	N.B.	-1.28	Midland	O.
0.99	Dolbeau	Q.	-1.30	Penticton	B.C.
0.97	Edmonton	A.	-1.34	Oromocto	N.B.
0.85	Rouyn	Q.	-1.35	Tillsonburg	O.
0.84	Trois-Rivieres	Q.	-1.40	Chilliwack	B.C.
0.82	Winnipeg	M.	-1.40	Smiths Falls	O.
0.79	Vernon	B.C.	-1.45	Orillia	O.
0.78	Prince George	B.C.	-1.53	Campbell River	B.C.
0.76	Sorel	Q.	-1.63	Yorkton	S.
0.65	Vancouver	B.C.	-1.70	Moose Jaw	S.
0.63	Grande Prairie	A.	-2.01	Brandon	M.
0.60	Asbestos	Q.	-2.09	Camrose	A.
0.60	St.John's	Nfld.	-2.15	Abbotsford	B.C.
0.56	Prince Rupert	B.C.	-2.19	Selkirk	O.
0.54	Granby	Q.	-2.45	Portage la Prairie	M.
0.53	Moncton	N.B.	-2.46	North Battleford	S.
0.52	Thompson	M.			

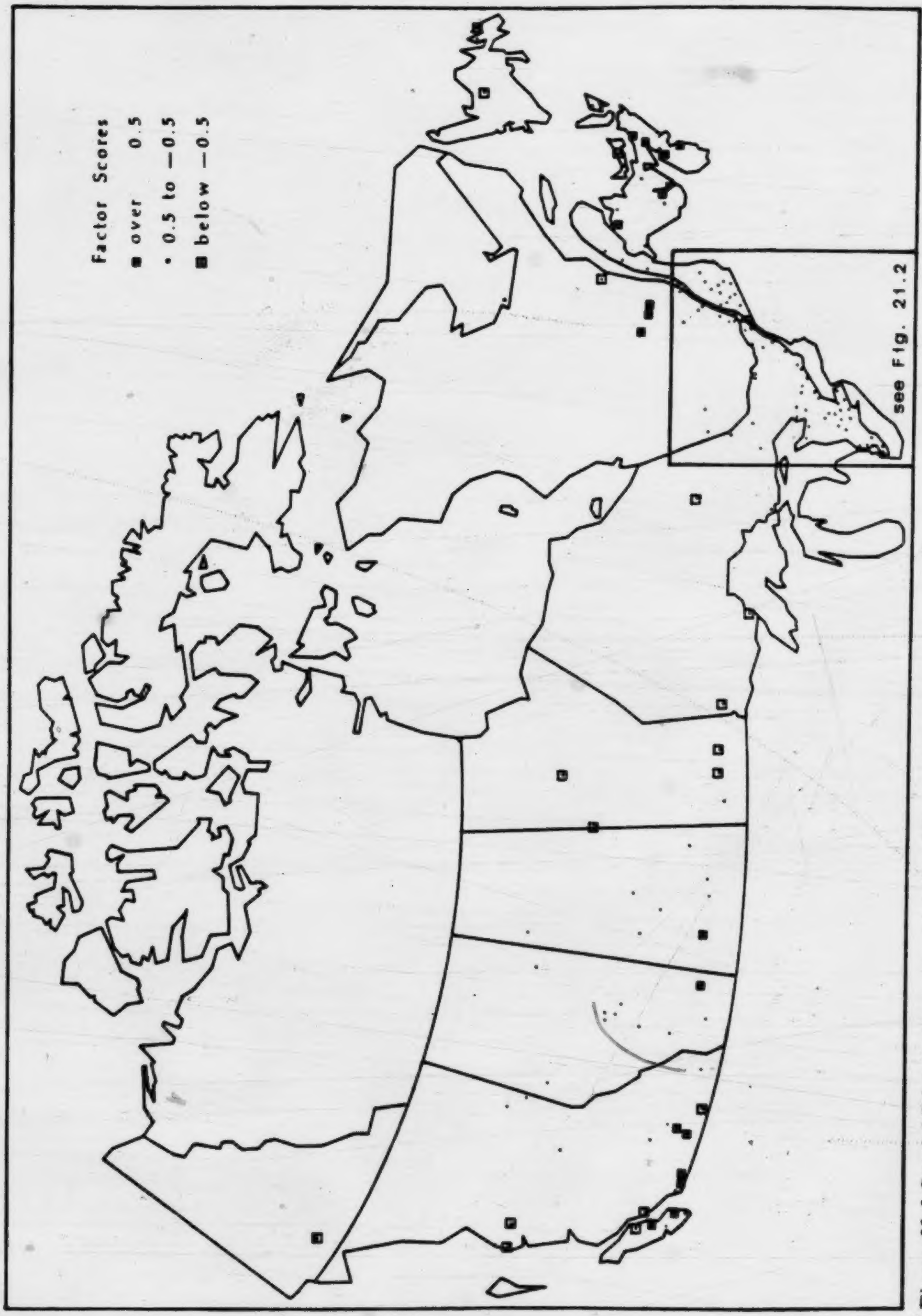

Factor Scores
■ over 0.5
• 0.5 to —0.5
▣ below —0.5
see Fig. 21.2

Figure 21.1 Spatial Distribution - the Values of Factor VI : 1981

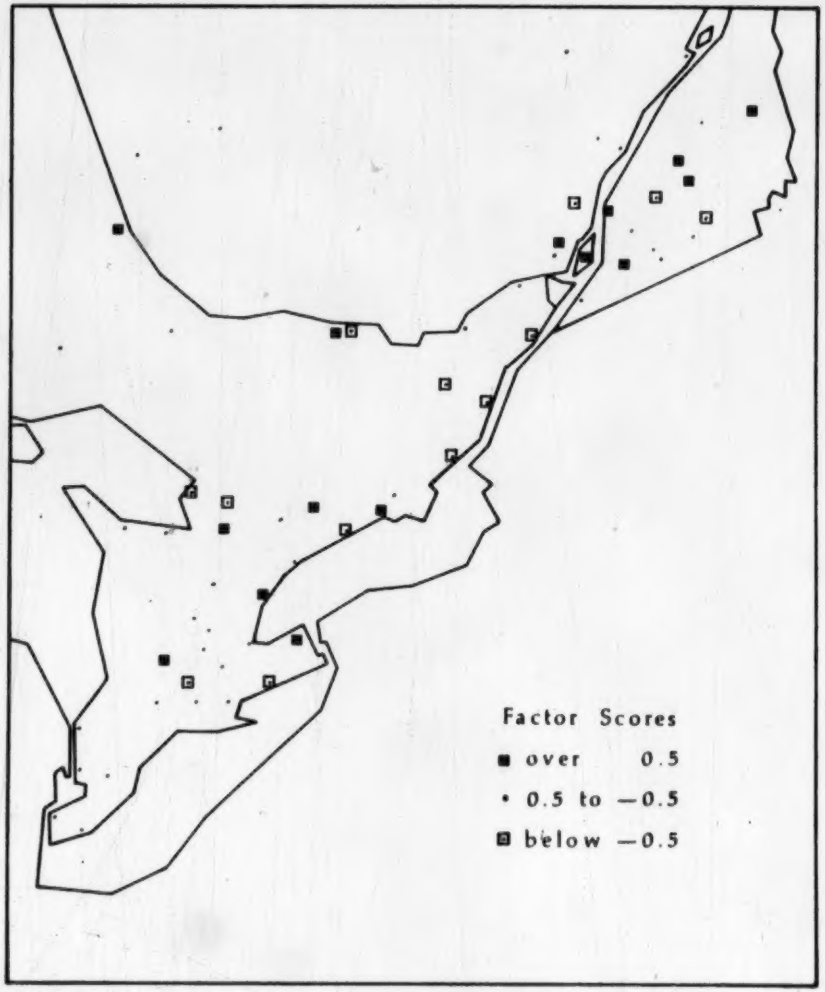
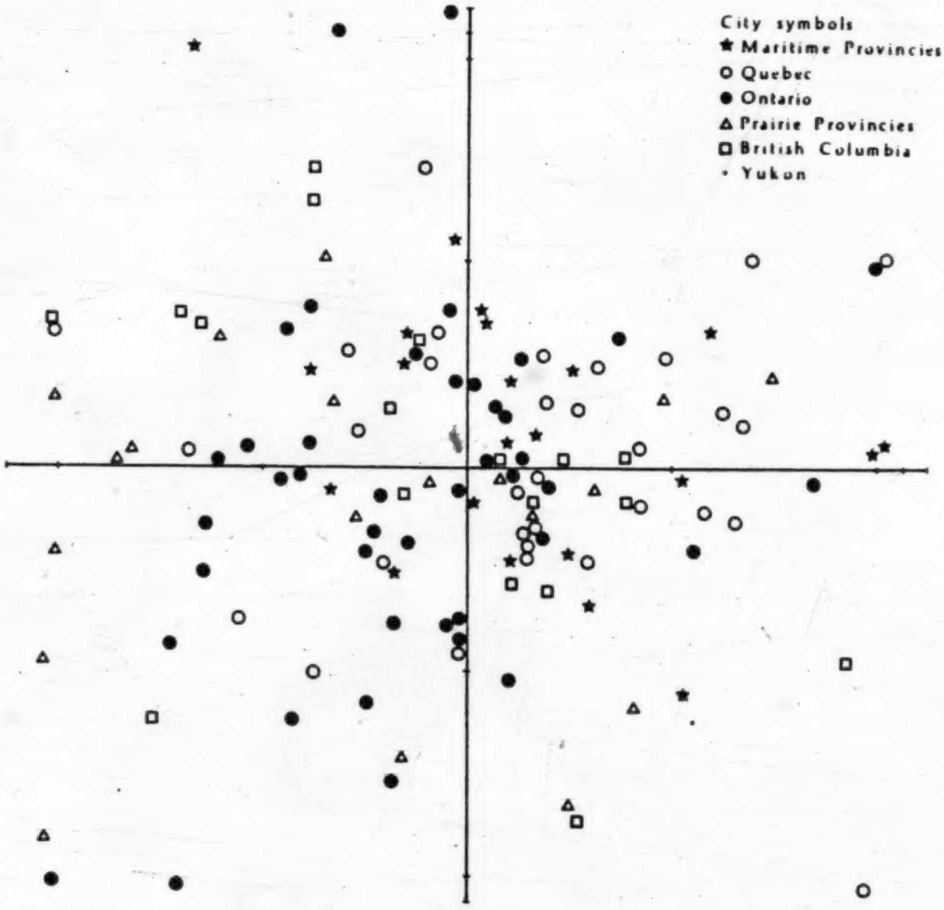

Factor Scores
■ over 0.5
• 0.5 to −0.5
▣ below −0.5

Figure 21.2 Spatial Distribution - the Values of Factor VI: 1981

Table 21. Factor Scores on Factor VI. 1981

Score	City	Province
7.02	St.Catharines-Niagara	O.
3.16	Petawawa	O.
1.51	Oromocto	N.B.
1.47	Courtenay	Q.
1.47	St.Georges	Q.
1.30	Kelowna	B.C.
1.11	Campbellton	N.B.
1.08	Alma	Q.
1.03	Montreal	Q.
1.01	Medicine Hat	A.
0.98	Toronto	O.
0.78	Trenton	O.
0.78	Barrie	O.
0.76	New Glasgow	N.S.
0.76	Chilliwack	B.C.
0.71	Penticton	B.C.
0.70	Truro	N.S.
0.69	Abbotsford	B.C.
0.67	Stratford	O.
0.66	Chicoutimi-Jonquiere	Q.
0.66	St.Jean	Q.
0.66	Corner Brook	Nfld.
0.65	Lunenburg	N.S.
0.64	Swift Current	S.
0.63	Sorel	Q.
0.61	Nanaimo	B.C.
0.56	Victoriaville	Q.
0.55	Peterborough	O.
0.55	Drummondville	Q.
0.53	Haileybury	O.
0.52	Dolbeau	Q.
0.51	Kentville	N.S.
0.51	St.Jerome	Q.
0.49	Summerside	P.E.I.
0.48	Vancouver	B.C.
-0.41	Chatham	O.
-0.43	Sydney Mines	N.S.
-0.45	Saint John	N.B.
-0.47	Asbestos	Q.
-0.47	Owen Sound	O.
-0.53	Charlottetown	P.E.I.
-0.53	Midland	O.
-0.57	Powell River	B.C.
-0.60	Trail	B.C.
-0.67	St.John's	Nfld.
-0.73	Joliette	Q.
-0.75	Brockville	O.
-0.76	Thunder Bay	O.
-0.76	Pembroke	O.
-0.83	Kingston	O.
-0.88	Orillia	O.
-0.90	Sherbrooke	Q.
-0.93	Terrace	B.C.
-0.94	Kapuskasing	O.
-0.95	Portage la Prairie	M.
-1.00	St.Hyacinthe	Q.
-1.04	Cornwall	O.
-1.12	Grand Falls	Nfld.
-1.16	Cobourg	O.
-1.16	Winnipeg	M.
-1.24	Woodstock	O.
-1.24	Whitehorse	Y.
-1.24	Campbell River	B.C.
-1.43	Flin Flon	M.-S.
-1.54	Kenora	O.
-1.65	Thompson	M.
-1.73	Prince Rupert	B.C.
-2.26	Selkirk	O.
-2.39	Smiths Falls	O.
-2.49	Baie-Comeau	Q.

Figure 22. Two Factor Space: Factor V and VI: 1981



reflects the service functions of small urban places. There are no significant negative loadings on this dimension, simplifying the interpretation. As it can be noted from Table 21., the large metropolitan cities of Canada load highly on this dimension as well. The strong association of Montreal, Toronto and Vancouver with the fifth and sixth dimension simultaneously reflects the complexity of the economic structures of these cities. In other words, the mutifunctional economic structure of these cities causes a correlation of their economic characteristics with both dimensions. This association emerges even more clearly on the diagram in Figure 22., where cities are plotted into two dimensional space formed by the fifth and sixth dimension.

The urban centers with a level of service employment above the average and high employment rate appear in the first quadrant of the diagram. On the opposite side (negative), there are small service centers with relatively simple employment structures located mainly in Ontario and the Prairie Provinces.

The spatial distribution of cities correlated with the sixth dimension is shown in Figures 21.1 and 21.2. The cities with the highest and the lowest factor scores are listed in Table 21. Both of them confirm that the dimension indexes the service character of small Canadian cities.

4.10 Economic Dimensions of the Canadian Urban System in 1981

The 1981 data matrix containing 27 variables and 140 cities has been reduced by means of the principal-component analysis to six factors. They account together for 62.8% of the total variance in the original data matrix. The subsequent interpretation of the factors allowed six dimensions to be defined. The major economic dimensions of the Canadian urban system in 1981 were identified as:

1. Metropolitan, white-collar, service-administrative character of the major urban centers of Canada.
2. High labor force participation ratio in manufacturing.
3. Manufacturing centers of the industrial heartland of Canada.
4. High rate of the population change associated with high employment in sales and

construction sectors.

5. Service character of large and medium size cities.
6. Service character of small cities.

The last two dimensions were interpreted on the basis of quite low factor loadings. Therefore, their interpretation has to be considered as inadequate. Similarly to the 1971 results, these two dimensions will not be considered in any further analysis. The remaining four dimensions in 1981 account for 51.8% of the total variance, that is, slightly more than in 1971 (50.8%). A comparative analysis of the aggregate results for 1971 and 1981 dimensions will be provided in the next chapter.

V. ANALYSIS OF THE RESULTS

5.1 Changes in the Economic Dimensions of the Canadian Urban System

In this chapter the focus shifts from the urban places themselves to the system of the Canadian cities as a whole. The seemingly complex interrelationships associated with this system have been summarized for 1971 and 1981 in terms of six factors for each of the data matrices. For at least four of these factors in the two analyses empirical interpretations were possible. As a result the major economic dimensions of the Canadian urban system in 1971 were identified as:

1. White-collar, service-administrative character of metropolitan centers of Canada.
2. High female employment in manufacturing and low unemployment in secondary sector associated with a high rate of population change.
3. Frontier-service centers.
4. Specialized manufacturing centers.

The economic dimensions in 1981 were identified as:

1. Metropolitan, white-collar, service-administrative character of the major urban centers of Canada.
2. High labor force participation rate in manufacturing.
3. Manufacturing centers of the industrial heartland of Canada.
4. High rate of the population change associated with high employment in sales and construction sectors.

Both analyses were based on exactly the same variables. Therefore, the results are directly comparable (see p.40). In 1971, the first four dimensions account for 50.8% of the total variance in the data matrix, while in 1981 it was 51.4%. An examination of the dimensions in 1971 and 1981 and, loadings associated with them, allows the conclusion to be drawn that the economic dimensions of the Canadian urban system were partially stable.

The first dimension in 1971, identified as the white-collar, service-administrative character of metropolitan centers in Canada, is exactly the same in 1981. A closer examination of the factor loadings (Figure 23.) reveals that the four highest (i.e. R22, R34, R15, F9) and the three lowest (i.e. R26, R33, F10) factor loadings are the same on both dimensions. The only noticeable difference is in the order of the variables. However, this does not affect the interpretation significantly. Moreover, both dimensions account for exactly the same percentage of the total variation in the data matrices, i.e. 20.9%. All of this illustrates a remarkable degree of stability in the system over the ten year period in the white-collar, service-administrative dimension.

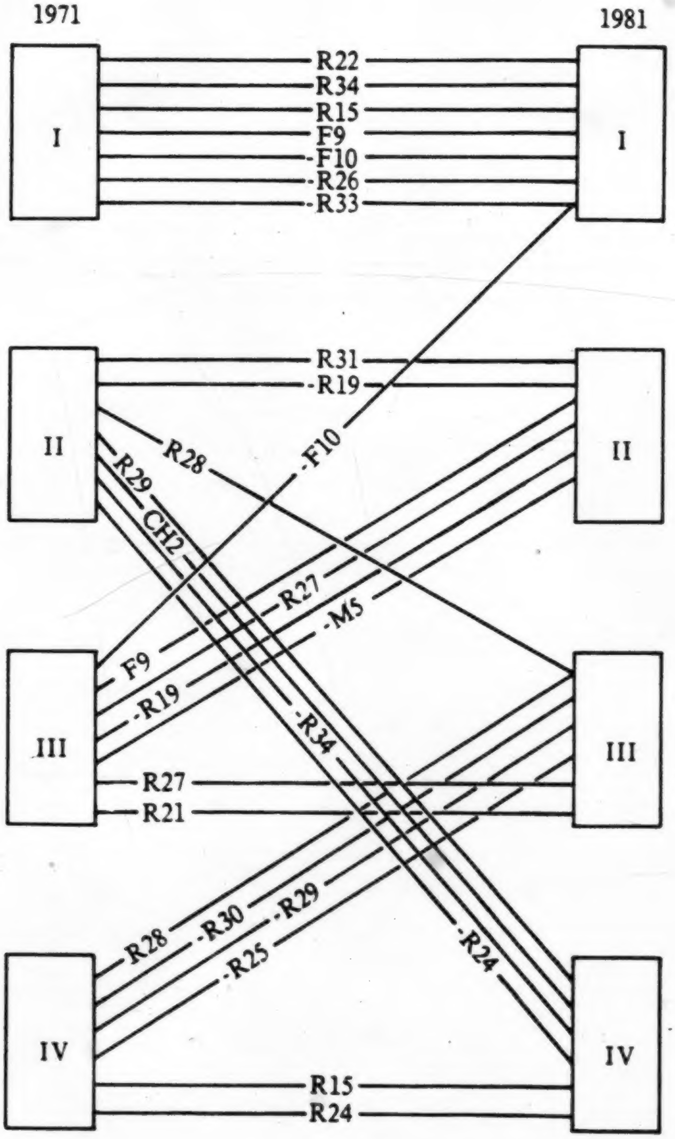
The remaning three dimensions account together for 29.9% of the variance in the 1971 data matrix and 30.4% in the 1981 data matrix. An examination of the factor loadings on these dimensions (Figure 23.) provides evidence for the conclusion that the rest of the economic dimensions were not stable over time.

The changes in the economic dimensions of the Canadian urban system can be summarized as follows:

The major economic dimension, that is, metropolitan, white-collar, service-administrative character of the urban centers in Canada, has been retained throughout the ten year period. The correspondance is very strong and accounts for 20.9% of the total variance in the data matrix, out of over 50% of the variance explained. This dimension shows the increasing role of the tertiary employment as the strongest component of the economic structure of the Canadian cities. The tendency existed already in 1971 and was stressed even more strongly in the 1981 analysis (Figure 23.). The shift of the employment in Canadian cities towards tertiary-service employment, occurred mostly at the expense of the secondary employment, particularly in manufacturing (Blackbourn & Putnam, 1984, pp.19-20).

The system, as represented by the remaining three dimensions, has changed over time (Figure 23.). The most significant change can be noted in the second dimension in 1971, that is, high female employment in manufacturing and low unemployment in the secondary sector

Figure 23. Changes in the Factor Loadings on the Economic Dimensions of the Canadian Urban System 1971-1981


1971
1981
I
I
R22
R34
R15
F9
-F10
-R26
-R33
II
II
R31
-R19
R28
R29
CH2
-F10
F9
-R19
R27
-M5
III
III
-R34
R27
R21
R28
-R30
-R29
-R25
-R24
IV
IV
R15
R24

associated with a high rate of population change. In terms of the variables, the most similar dimension in 1981 to it is the fourth one, interpreted as - a high rate of population change associated with high employment in sales and construction sectors. The two dimensions are partially alike. However, the female employment factor declined in 1981, suggesting a more even distribution of the employment along male and female components. Moreover, the relative importance of the population change associated with high manufacturing employment has declined in 1981. A similar tendency can be noted when the third dimension in 1971 is considered. This dimension - frontier service centers - is partially similar in its factor loadings to the second dimension in 1981 - high labor force participation ratio in manufacturing. However, the empirical interpretation of the second dimension in 1981 is quite different from that of 1971. Therefore, it can be concluded that the relative importance of the frontier-service type of city has declined in Canada over the period 1971-1981. The opposite trend emerges when the fourth dimension - specialized manufacturing centers - is examined. This dimension resembles, both in terms of its factor loadings and the empirical interpretation, the third dimension in 1981, namely - manufacturing centers of the industrial heartland of Canada. Hence, the significance of manufacturing, particularly in the core region of Canada, has increased over the period under study.

To summarize, the significance of the tertiary and white-collar employment has increased in the economic structure of the Canadian urban system. This change has occurred at the expense of secondary employment. At the same time, the relative importance of the population change and female employment, as indexed by the second dimension in 1971, decreased showing a decline in the significance of demographic factors in the economic structure of the Canadian urban system.

Two other aspects of the economic structure of the Canadian urban system emerged in the analysis. Firstly, as was outlined in the first chapter of the thesis, if the process of urban concentration occurs in the system, variables indexing tertiary and service employment will emerge more clearly in the 1981 analysis. Since the first dimension, both in 1971 and in 1981 indexes white-collar tertiary employment, and the factor loadings on the first dimension in 1981 are indeed stronger than in 1971, it can be concluded that the first dimension indexes a very strong trend in the system towards progressive urban concentration. Secondly, the increase in the relative significance of the service employment in the economic dimensions of the system implies an economic evolution of the cities in Canada.

In the following section, changes in the spatial distribution of the urban centers associated with the economic dimensions will be discussed.

5.2 Spatial Changes in the Economic Structure of the Canadian Urban System

The changes in the structure of the economic dimensions on an aggregate scale for the Canadian urban system were examined. Now the focus of the discussion will shift to changes in the spatial structure of the cities associated with these dimensions.

In order to examine these changes, firstly, the most significant factor scores (i.e. factor scores +1.0) of cities having in 1971 and 1981 populations over 10,000 were used to determine fifteen types of cities; Type A for 1971 and Type B for 1981 (Table 22.). In other words, cities which scored significantly on at least one dimension were then grouped into fifteen major economic types in 1971 and again in 1981. Secondly, the groups of cities were mapped according to their respective economic types. The results are shown in Figures 20. to 27.

The first five types were mapped together as a single category, since all of them index the most economically diversified cities, which had factor scores - +1.0, on at least three dimensions. An examination of the groups of cities, both in 1971 (Table 23.) and in 1981 (Table 24.), reveals that there were very essential changes over the ten year period. Three cities - Ottawa-Hull, Arnprior and Montreal - with the most diversified economic profiles in 1971 do not appear in 1981. Instead, there were four other cities in 1981 - Vancouver, St.Catharines-Niagara, Tillsonburg and Edmonton. This shift suggests a relative decline of the importance of manufacturing employment in Ottawa-Hull and Montreal in 1981. Moreover, Toronto, which scored high on all four dimensions in 1971, indicating its dominant role in the

Table 22.1 Economic Types of the Canadian Cities: 1971

Symbol Type	Description
IA	Diversified metropolitan center chracterized by high employment in white-collar, tertiary sector; high female and secondary sector employment; high population change; high service and manufacturing employment.
IIA	Diversified metropolitan center characterized by high employment in white-collar, tertiary sector; high female and secondary sector employment; high population change; high service employment.
IIIA	Diversified metropolitan center characterized by high female and secondary sector employment; high population change; high service and manufacturing employment.
IVA	Diversified center characterized by high employment in white-collar, tertiary sector; high female and secondary sector employment; high population change and manufacturing employment.
VA	Diversified metropolitan center characterized by high employment in white-collar, tertiary sector; high service and manufacturing employment.
VIA	City characterized by high employment in white-collar tertiary sector; high female and secondary sector sector employment; high population change.
VIIA	City characterized by high employment in white-collar, tertiary sector and high service employment.
VIIIA	City characterized by high employment in white-collar, tertiary sector and high manufacturing employment.
IXA	City characterized high female and secondary sector employment; highpopulation change and service employment.
XA	City characterized by high female and secondary sector employment; high population change; high manufacturing employment.
XIA	City characterized by high service and manufacturing employment.
XIIA	City characterized by high employment in white-collar, tertiary sector.
XIIIA	City characterized by high female and secondary sector employment; high population change.
XIVA	City characterized by high service employment.
XVA	City characterized by high manufacturing employment.

Table 22.2 Economic Types of the Canadian Cities: 1981

Map Symbol	Type	Description
	IB	Does not occur.
	IIB	Diversified metropolitan center characterized by high employment in white-collar, tertiary sector; high participation rate in manufacturing and high employment in manufacturing.
	IIIB	Does not occur.
	IVB	Diversified center characterized by high employment in white-collar, tertiary sector; high participation rate in manufacturing and high employment in manufacturing.
	VB	Diversified metropolitan center characterized by high employment in white-collar, tertiary sector; high manufacturing employment; high population change and high service employment.
	VIB	City characterized by high employment in white-collar tertiary sector and high participation rate in manufacturing.
	VIIB	City characterized by high employment in white-collar tertiary sector and high manufacturing employment.
	VIIIB	City characterized by high employment in white-collar tertiary sector; high population change and high service employment.
	IXB	City characterized by high participation rate in manufacturing and high manufacturing employment.
	XB	City characterized by high participation rate in manufacturing; high population change and high service employment.
	XIB	City characterized by high manufacturing employment; high population change and high service employment.
	XIIB	City characterized by high employment in white-collar, tertiary sector.
	XIIIB	City characterized by high participation rate in manufacturing.
	XIVB	City characterized by high manufacturing employment.
	XVB	City characterized by high population change and high service employment.

Canadian urban system, has fallen into one group together with Vancouver and Winnipeg in 1981. Interestingly, Calgary in both analyses clusters together with Whitehorse. This contiguity has been confirmed in the 1981 analysis where the group Calgary, Whitehorse has been enlarged by the inclusion of Edmonton (Table 24.). In both analyses all of these cities score highly on all of the dimensions, except the fourth in 1971 and the third in 1981. All of the cities represented by the types I, II, III and V have very high scores on the first dimension indicating a bias towards tertiary employment. The cities indexed by Type IVA and IVB should be considered separately from the rest, since they do not score highly on the first dimension. The economic diversification of Arnprior Type IVA (Table 18.) - is due to its very high employment in the secondary sector, mostly machinery occupations. However, this city is not included in the 1981 analysis, due to a decline in its population to below 10,000.

Two cities represented by Type IVB in 1981 - St.Catharines-Niagara and Tillsonburg - have very high levels of manufacturing employment. Consequently, they form a separate group. In particular St.Catharines-Niagara has a very significant service sector due to a high employment in the recreation industry. Both of these cities are located in Southern Ontario, in relative proximity to Toronto (Figure 25.2). The rest of the cities in the first five groups in 1981 are located in the Prairie or Western Provinces (Figure 25.1). This distribution is quite different from that of 1971, where four out of seven cities were located in Southern Quebec and Ontario (Figures 24.1 and 24.2).

The second broad group of cities, defined as diversified cities, is characterized by high scores on at least two dimensions, i.e. high scores on either the second or the third or fourth dimension (Table 22.). The cities with high scores on these dimensions were classified as Type VI, VII and VIII (A and B). All of them have a significantly high employment in the white-collar tertiary sector, which differentiates them from the next broad group of cities, indexed as Type IX, X and XI (Table 22.). These have high scores on either the second, third or fourth dimension but not on the first one. The spatial distribution of Type VI to VIII cities in 1971 differs significantly from the distribution in 1981. The first group - Type VIA - in

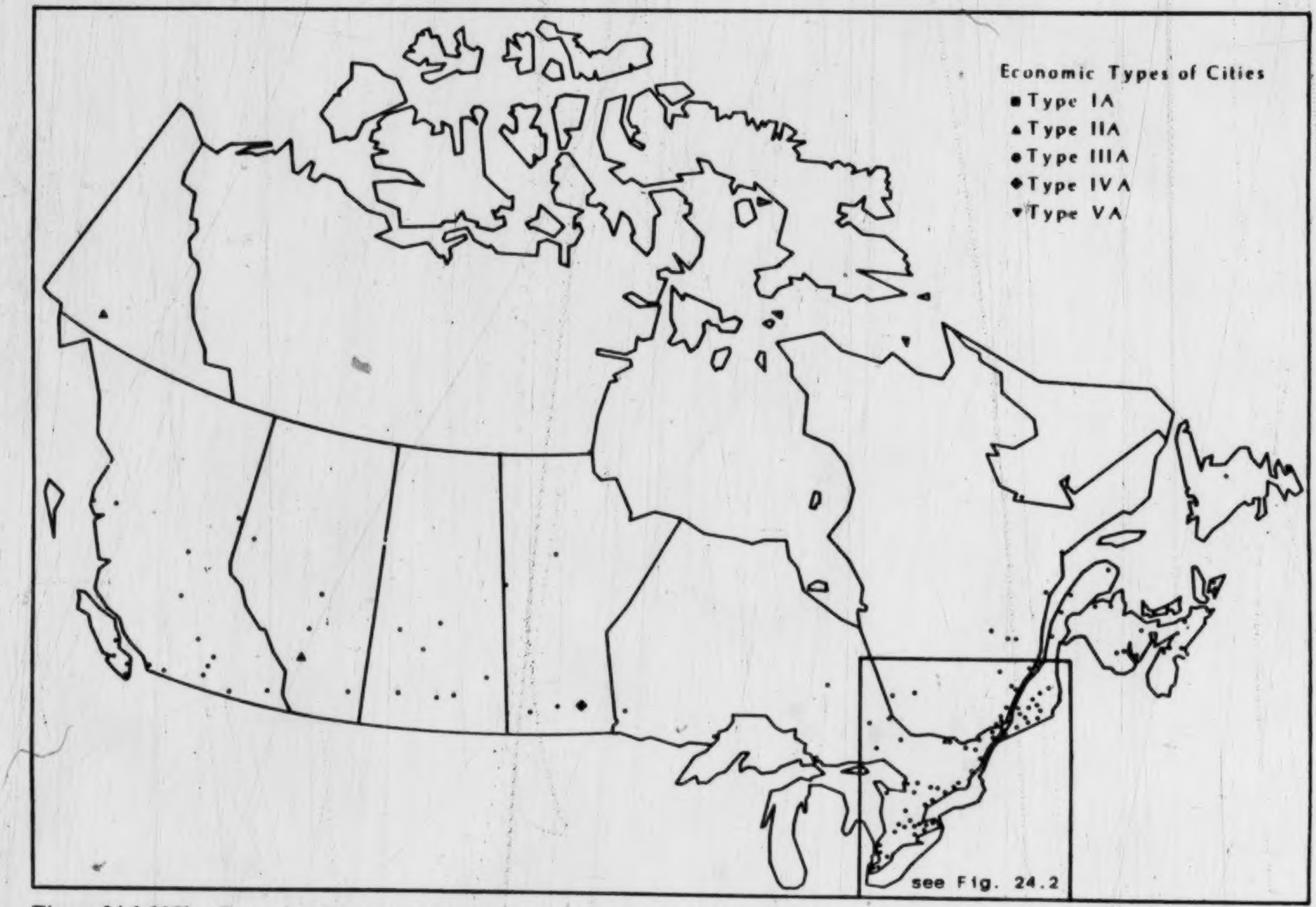

Economic Types of Cities
■ Type IA
▲ Type IIA
● Type IIIA
◆ Type IVA
▼ Type VA
see Fig. 24.2

Figure 24.1 1971 - Economic Types of Cities: Type IA, IIA, IIIA, IVA, VA.

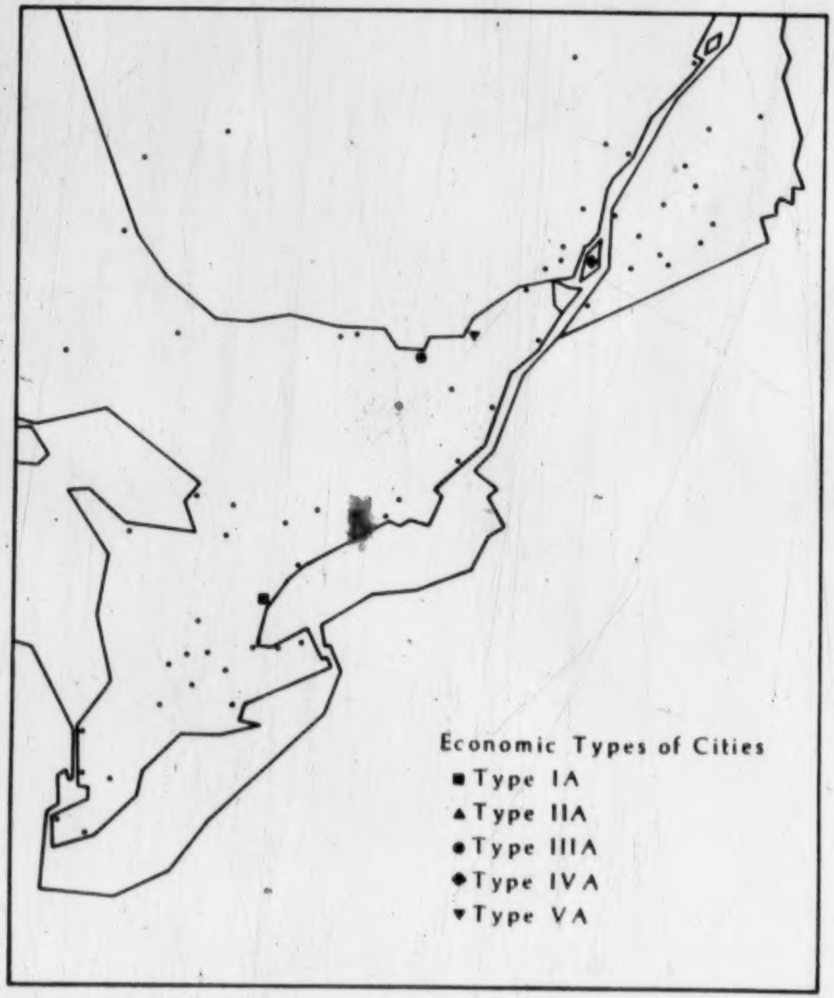

Economic Types of Cities
■ Type IA
▲ Type IIA
● Type IIIA
◆ Type IVA
▼ Type VA

Figure 24.2 1971 - Economic Types of Cities: Type IA, IIA, IIIA, IVA, VA.

Table 23. Economic Types of the Canadian Cities in 1971. Type IA, IIA, IIIA, IVA, VA.

Type	Dimensions	City	Province
IA	I,II,III,IV,	Toronto	O.
IIA	I,II,III,	Calgary Whitehorse	A. Y.
IIIA	I,III,IV,	Ottawa-Hull	O.-Q.
IVA	II,III,IV,	Arnprior	O.
VA	I,II,IV,	Montreal Winnipeg	Q. M.

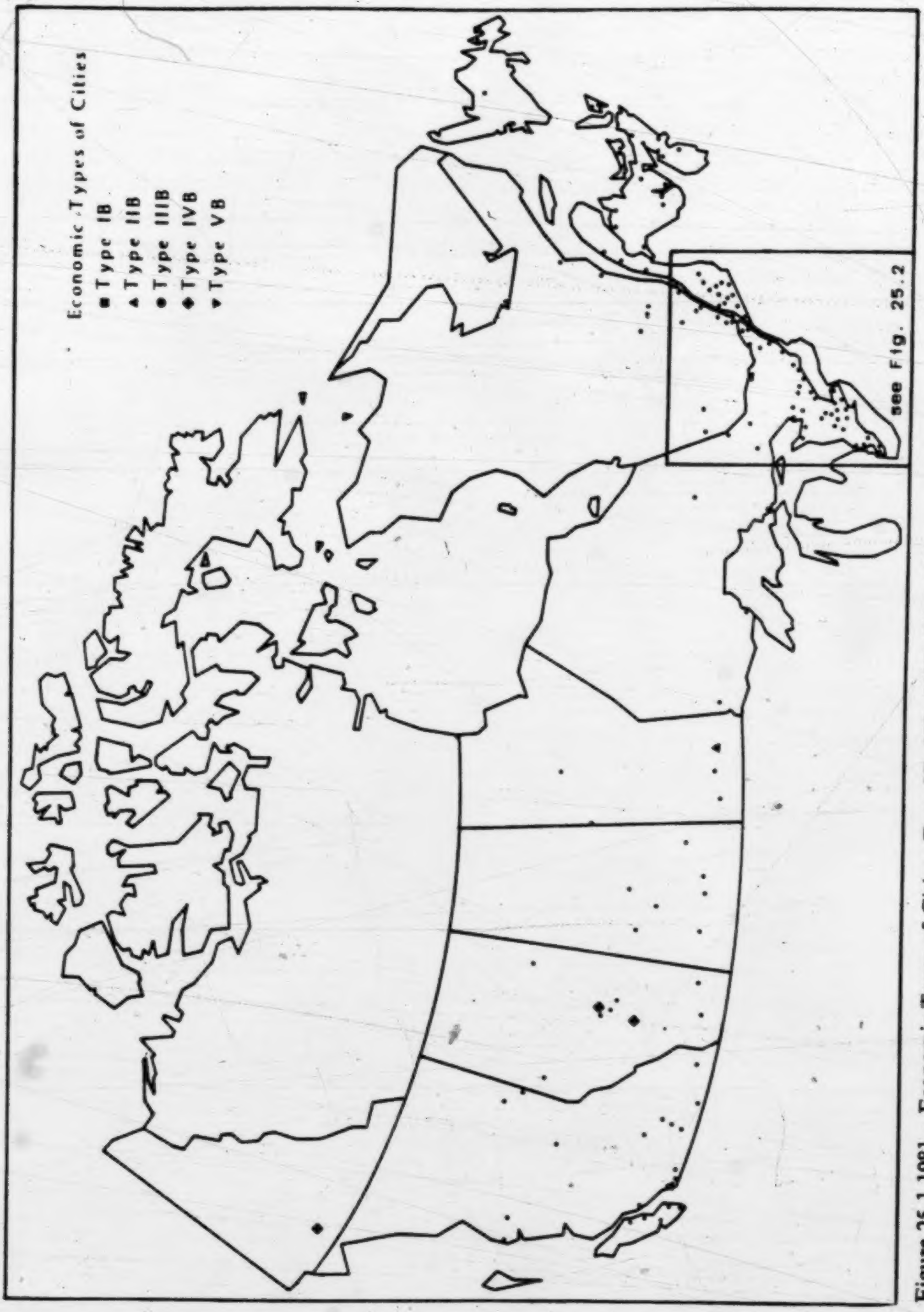

Economic Types of Cities
■ Type IB
▲ Type IIB
● Type IIIB
◆ Type IVB
▼ Type VB
see Fig. 25.2

Figure 25.1 1981 - Economic Types of Cities: Type IB, IIB, IIIB, IVB, VB.

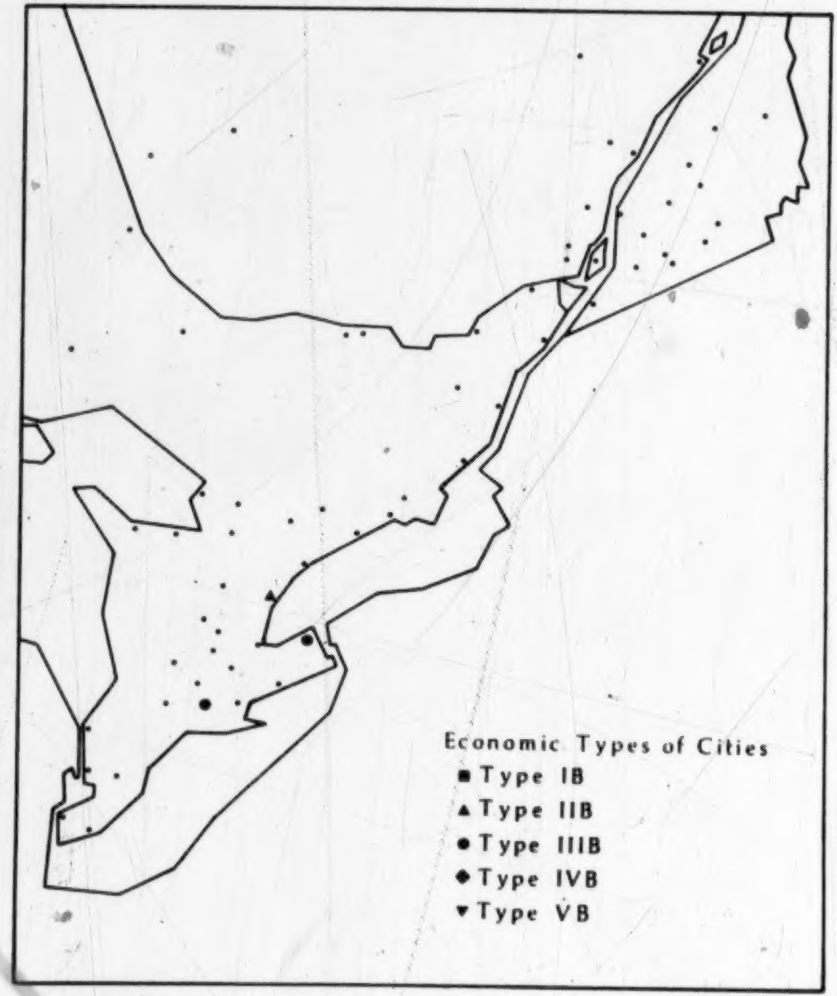

Economic Types of Cities
■ Type IB
▲ Type IIB
● Type IIIB
◆ Type IVB
▼ Type VB

Figure 25.2 1981 - Economic Types of Cities: Type IB, IIB, IIIB, IVB, VB.

Table 24. Economic Types of the Canadian Cities in 1981.
Type IB, IIB, IIIB, IVB, VB.

Type	Dimensions	City	Province
IB	I,II,III,IV,	Does not occur	
IIB	I,II,III,	Toronto	O.
		Vancouver	B.C.
		Winnipeg	M.
IIIB	I,III,IV,	Does not occur	
IVB	II,III,IV,	St.Catharines-Niagara	O.
		Tillsonburg	O.
VB	I,II,IV,	Calgary	A.
		Edmonton	A.
		Whitehorse	Y.

1971, occurs only in the Western and Maritime Provinces, except for two urban places located in Ontario, Barrie and London. The second most distinct group is formed by cities indexed as Type VIIIA are located in Southern Ontario and Quebec. Only one city from outside this area is present in this group - North Battleford. Of the cities with high factor scores on the first dimension, those located in British Columbia and the Prairie Provinces (eg. Kamloops, Lethbridge, Saskatoon) had high female employment levels in manufacturing as well as a high rate of population change. The rest were located in Southern Ontario and Quebec and were characterized by high levels of manufacturing employment.

The division of the economic profiles between cities located in the heartland and the rest of the country is present both in 1971 and 1981. The only significant exception were cities of the Maritime Provinces which did not emerge in this category (Type VIB to VIIIB) in 1981. Moreover, two major Western cities Vancouver and Edmonton, which had high factor scores on two dimensions in 1971, moved to a new group in 1981 Type IIB and VB. At the same time Montreal, which had three significant factor scores in 1971, declined in economic diversification in 1981 and emerged as Type VIIB together with Ottawa-Hull and Quebec (Table 26.). This distribution suggests a shift in the economic structure of Canadian cities towards an increasing economic diversification (expressed as the number of the high factor scores on the economic dimensions) of cities located in British Columbia and the Prairie Provinces. At the same time some of the diversified multifunctional urban centers of the heartland of Canada such as Montreal or Quebec declined economically. Cities of the Maritime Provinces do not appear in any of the eight groups reviewed so far. This suggests a relatively low level of economic diversification in the employment profiles of these cities (Blackbourn & Putnam, 1984, p.118).

The next broad group of cities which has been described already (p.122) includes Type IX, X and XI (Table 22). The cities in this group are characterized by very significant factor scores on either the second, third or fourth dimension but not on the first one. All of them can be described as economically diversified urban places with either high employment in the secondary sector or in manufacturing. It can be expected that a significant number of them will

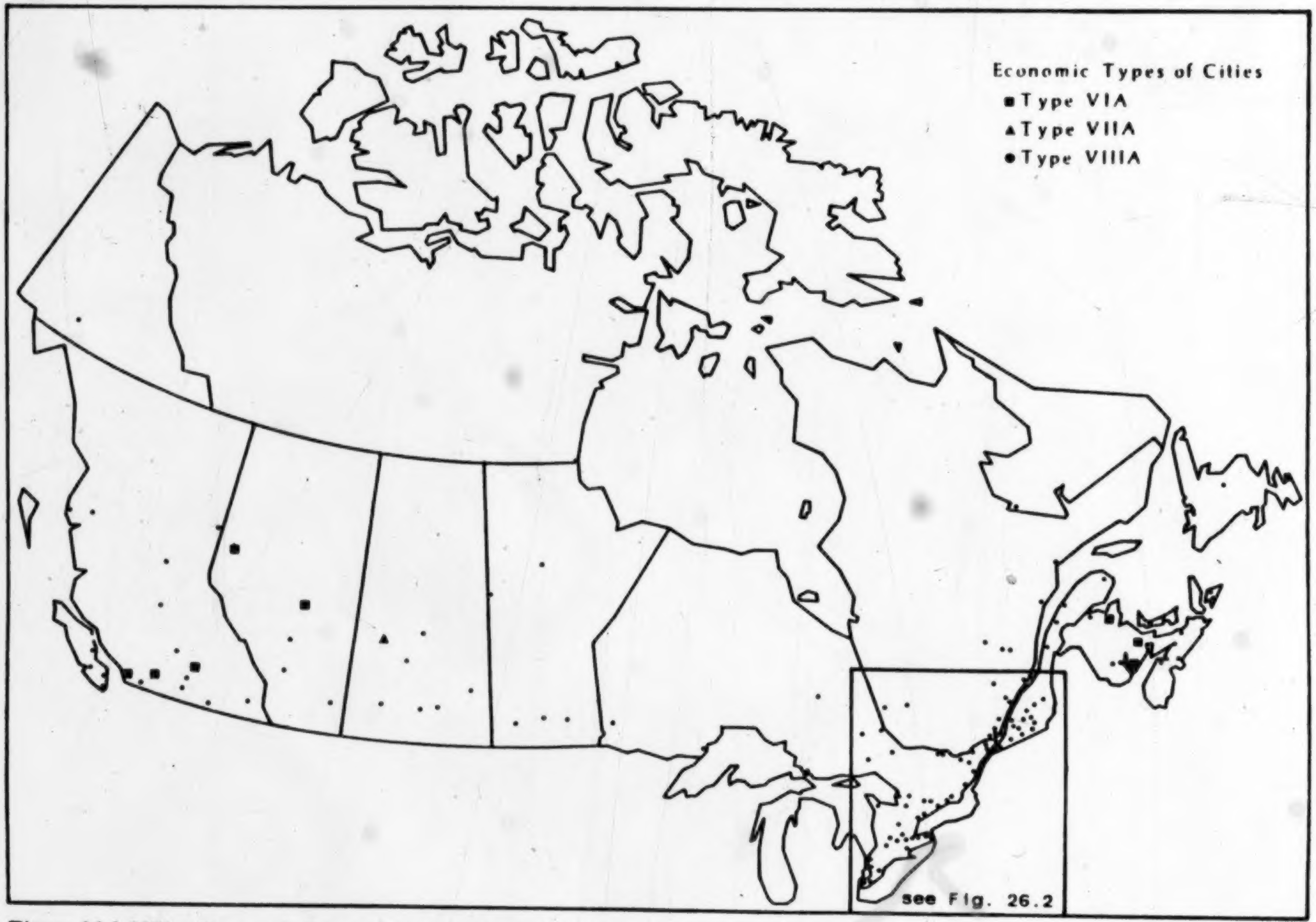

Economic Types of Cities
■ Type VIA
▲ Type VIIA
● Type VIIIA
see Fig. 26.2

Figure 26.1 1971 - Economic Types of Cities: Type VIA, VIIA, VIIIA.

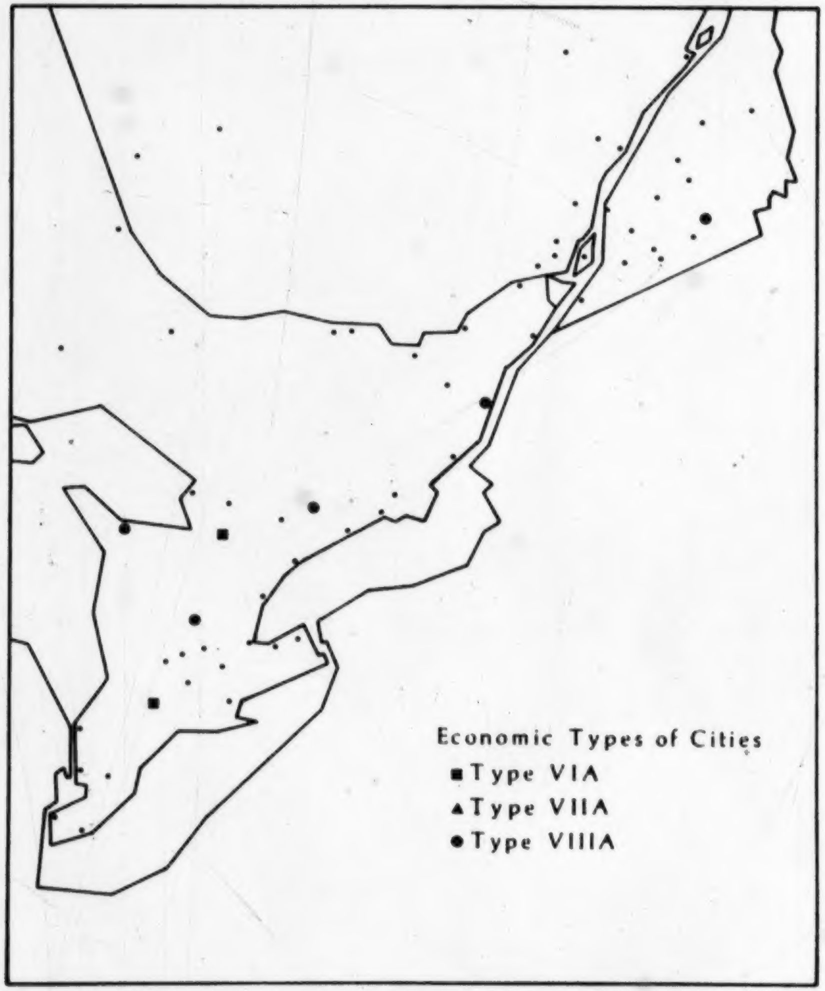

Economic Types of Cities
■Type VIA
▲Type VIIA
●Type VIIIA

Figure 26.2 1971 - Economic Types of Cities: Type VIA, VIIA, VIIIA.

d

Table 25. Economic Types of the Canadian Cities in 1971. Type VIA, VIIA, VIIIA.

Type	Dimensions	City	Province
VIA	I,II,	Barrie	O.
		Bathurst	N.B.
		Edmonton	A.
		Grande Prairie	A.
		London	O.
		Moncton	N.B.
		Saint John	N.B.
		Vancouver	B.C.
		Vernon	B.C.
VIIA	I,III,	North Battleford	S.
VIIIA	I,IV,	Brockville	O.
		Guelph	O.
		Owen Sound	O.
		Peterborough	O.
		Sherbrooke	Q.

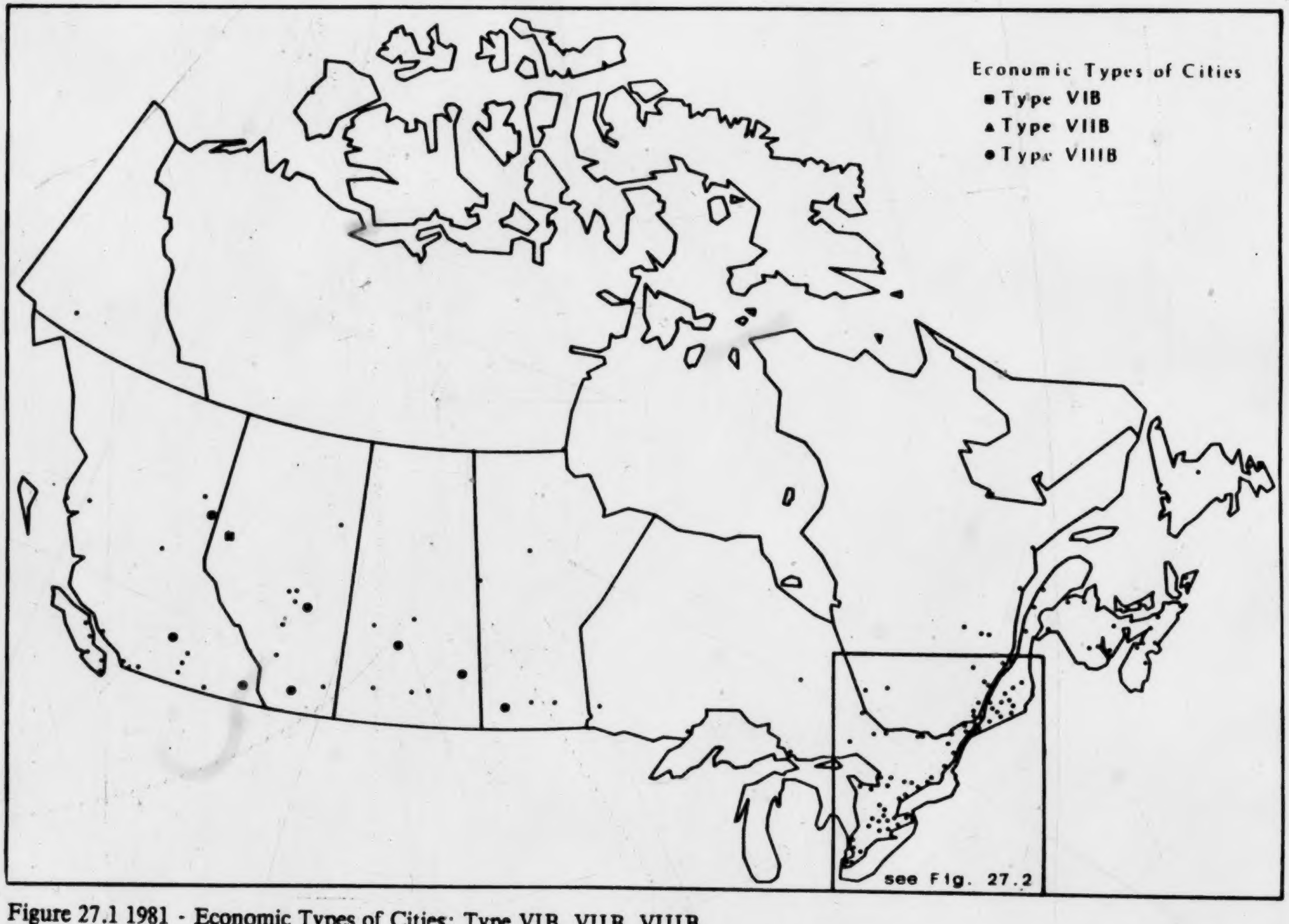

Economic Types of Cities
■ Type VIB
▲ Type VIIB
● Type VIIIB
see Fig. 27.2

Figure 27.1 1981 - Economic Types of Cities: Type VIB, VIIB, VIIIB.

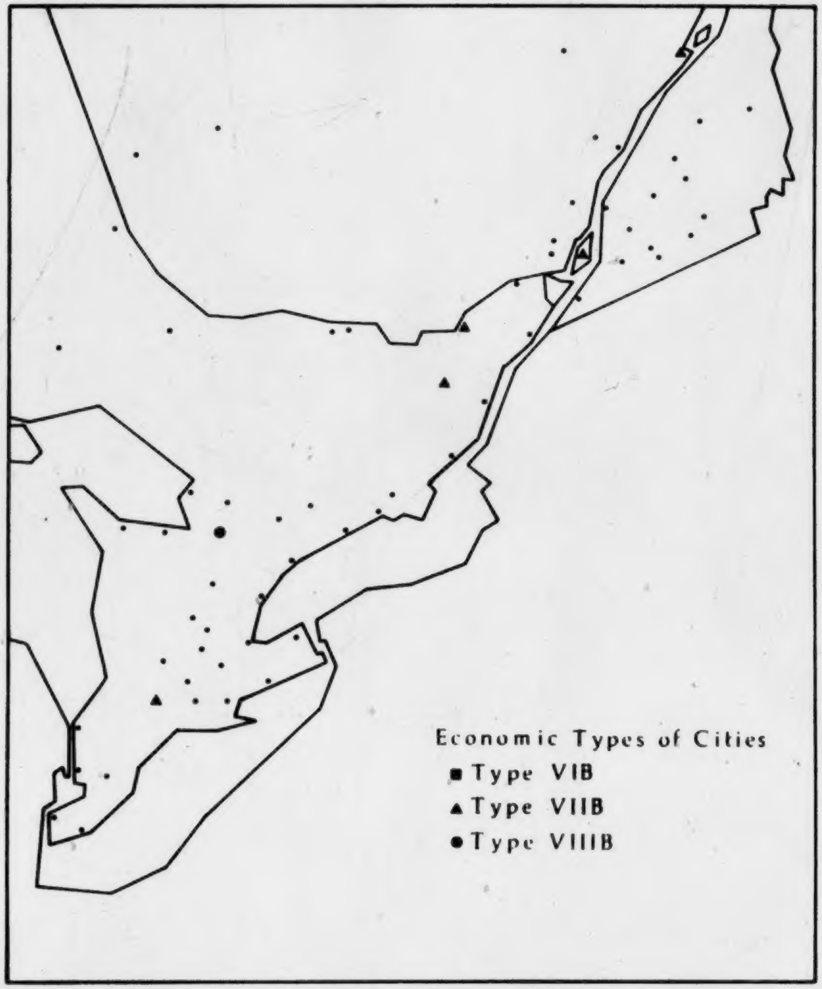

Economic Types of Cities
■ Type VIB
▲ Type VIIB
● Type VIIIB

Figure 27.2 1981 - Economic Types of Cities: Type VIB, VIIB, VIIIB.

Table 26. Economic Types of the Canadian Cities in 1981.
Type VIB, VIIB, VIIIB.

Type	Dimensions	City	Province
VIB	I,II,	Grande Prairie	A.
VIIB	I,III,	London	O.
		Montreal	Q.
		Ottawa-Hull	O.-Q.
		Quebec	Q.
		Smiths Falls	O.
VIIIB	I,IV,	Barrie	O.
		Brandon	M.
		Camrose	A.
		Cranbrook	B.C.
		Dawson Creek	B.C.
		Kamloops	B.C.
		Lethbridge	A.
		Saskatoon	S.
		Yorkton	S.

cluster in the industrial heartland of Canada. The spatial distribution shown on Figures 28.1, 28.2 and 29.1, 29.2 confirms this assumption. There is a very clear cluster of cities in Southern Ontario in 1971 (Figure 28.2). A very similar cluster is present in 1981 (Figure 29.2) in Southern Ontario and Quebec (Type IXB). Characteristically, all of the urban places indexed as manufacturing cities were located near Toronto. This spatial distribution can be accounted for by the process of centralization of the economic activities within or very near major metropolitan centers of Canada. The hypothesis formulated by King (1966) and outlined in the first chapter of the thesis states that if the Canadian urban system is evolving towards progressive metropolitanization, a sharp differentiation of the economic dimensions between urban centers located within or near the metropolitan areas and the rest of Canada should emerge more clearly over time. In particular, dimensions indexing manufacturing and service activities will appear more strongly in 1981 than in 1971. Comparing Figure 28. with 29., it can be seen that there is a higher concentration of manufacturing centers around Toronto in 1981 (Type IXB) , than in 1971 (Type XA). Moreover, none of the cities outside the industrial heartland of Canada has the same combination of economic dimensions both in 1971 and 1981. The rest of the cities ~~identified~~ as Type IXA, XIA and XB, XIIB are located in the Western Provinces.

There is also a change in distribution of the urban centers located outside Southern Ontario and Quebec. In 1971 most of the cities of Type IXA were located in British Columbia. However, they do not form any distinct cluster around any major metropolitan area (Figure 24.1). Therefore, the metropolitanization hypothesis is only partially confirmed. In 1981 such a cluster emerged in the Edmonton-Calgary corridor, indicating the possible development of a new region of economic concentration, at least at that point in time (Walker, 1980, p.198).

In short, there are two important aspects of change in the spatial distribution of the Canadian urban system which can be expressed up to this point. Firstly, there is a change in the employment structure of the Canadian cities due to the progressive concentration of the secondary and manufacturing sectors in the industrial heartland of Canada, particularly in

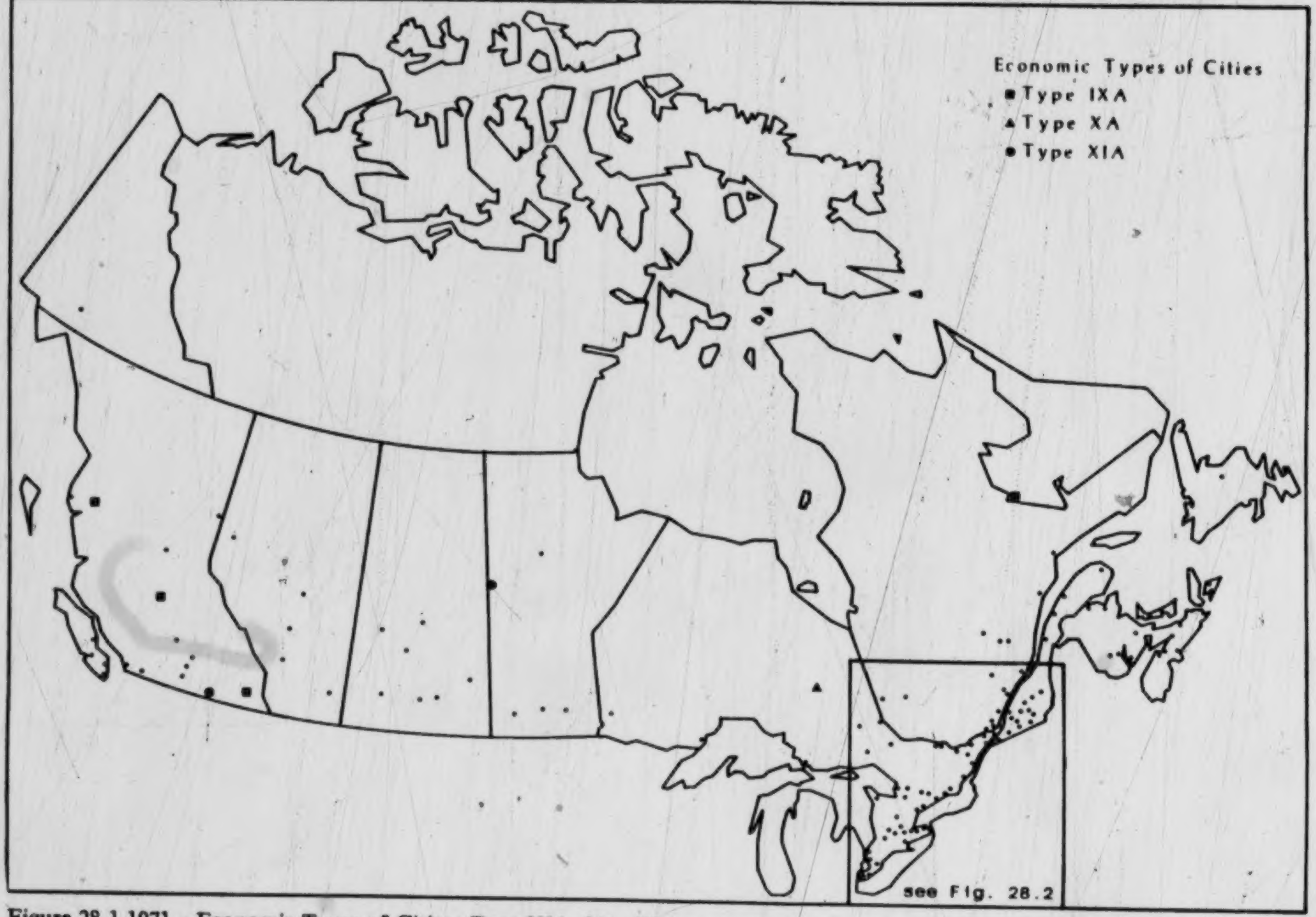

Economic Types of Cities
■ Type IXA
▲ Type XA
● Type XIA
see Fig. 28.2

Figure 28.1 1971 - Economic Types of Cities: Type IXA, XA, XIA.

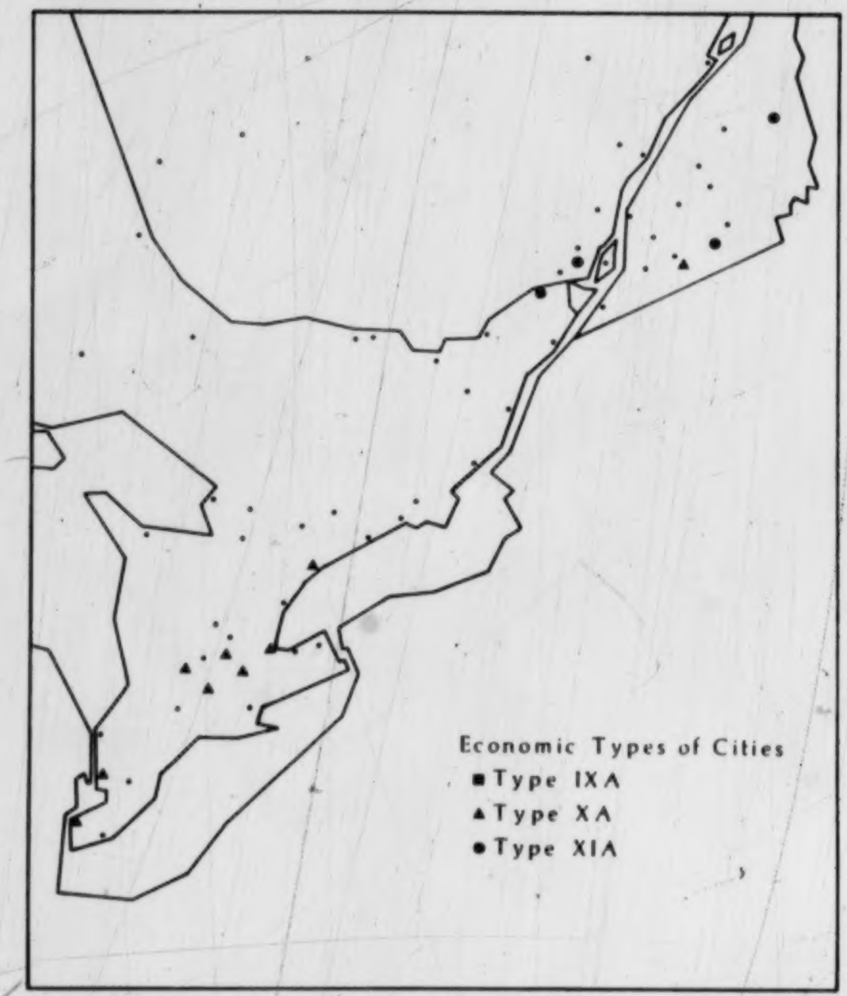

Economic Types of Cities
■ Type IXA
▲ Type XA
● Type XIA

Figure 28.2 1971 - Economic Types of Cities: Type IXA, XA, XIA.

Table 27. Economic Types of the Canadian Cities in 1971.
Type IXA, XA, XIA.

Type	Dimensions	City	Province
IXA	II,III,	Cranbrook	B.C.
		Labrador City	Nfld.
		Terrace	B.C.
		Williams Lake	B.C.
XA	II,IV,	Brantford	O.
		Cowansville	Q.
		Hamilton	O.
		Kapuskasing	O.
		Kitchener	O.
		Oshawa	O.
		Stratford	O.
		Wallaceburg	O.
		Windsor	O.
		Woodstock	O.
XIA	III,IV,	Hawkesbury	O.-Q.
		Flin-Flon	M.-S.
		Lachute	Q.
		Magog	Q.
		St.Georges	Q.
		Trail	B.C.

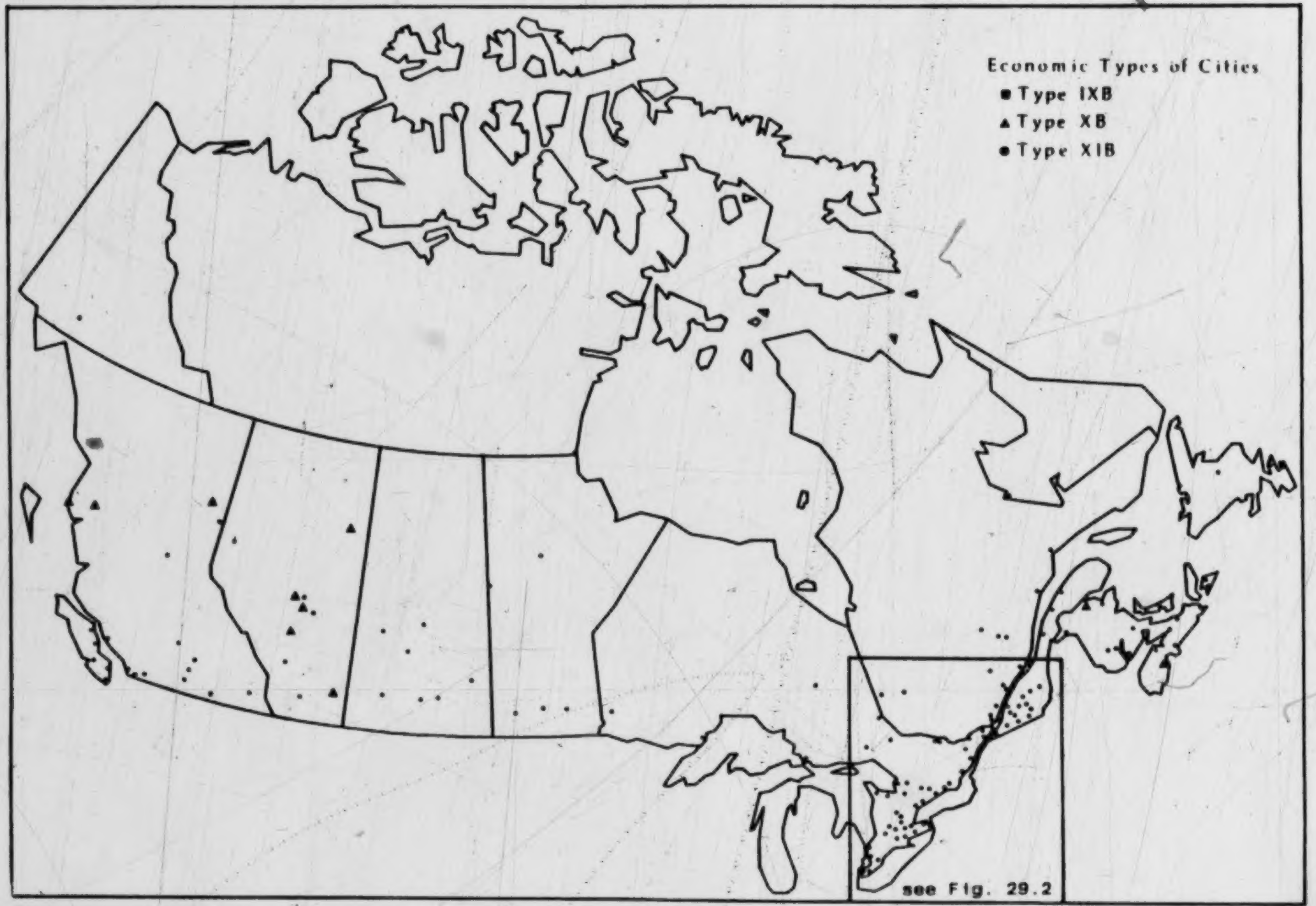

Economic Types of Cities
■ Type IXB
▲ Type XB
● Type XIB
see Fig. 29.2

Figure 29.1 1981 - Economic Types of Cities: Type IXB, XB, XIB.

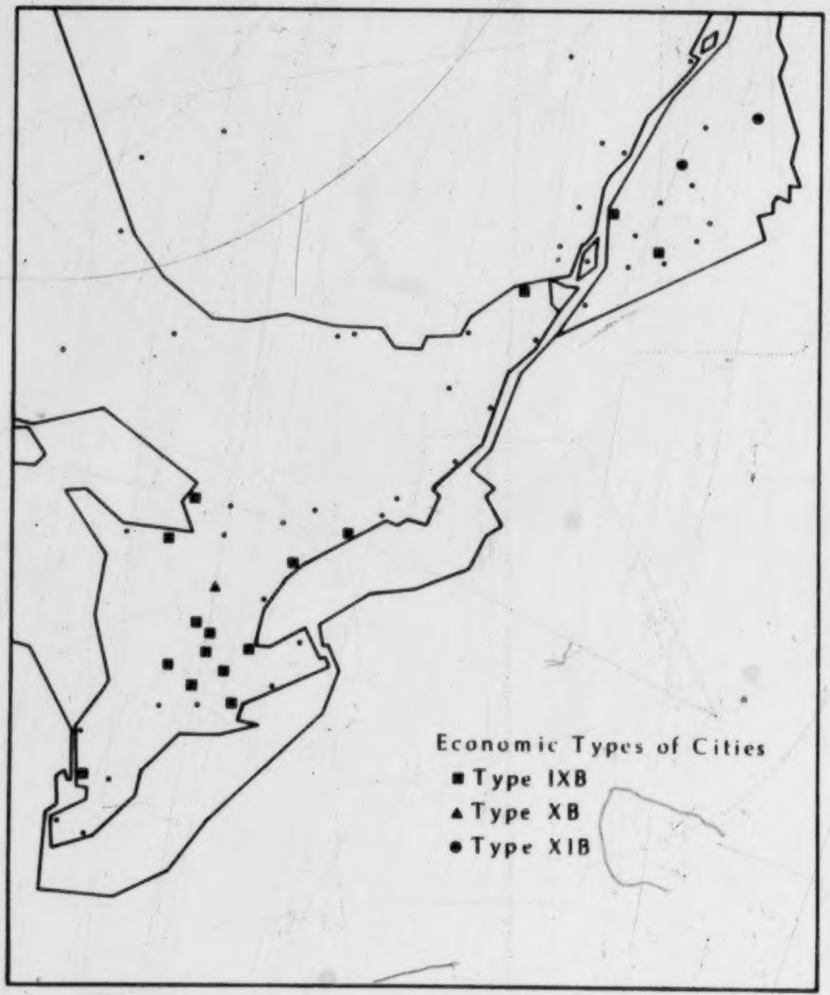

Economic Types of Cities
■ Type IXB
▲ Type XB
● Type XIB

Figure 29.2 1981 - Economic Types of Cities: Type IXB, XB, XIB.

Table 28. Economic Types of the Canadian Cities in 1981.
Type IXB, XB, XIB.

Type	Dimensions	City	Province
IXB	II,III,	Brantford	O.
		Cobourg	O.
		Collingwood	O.
		Fergus	O.
		Granby	Q.
		Guelph	O.
		Hamilton	O.
		Hawkesbury	O.-Q.
		Kitchener	O.
		Midland	O.
		Oshawa	O.
		Simcoe	O.
		Sorel	Q.
		Stratford	O.
		Wallaceburg	O.
		Woodstock	O.
XB	II,IV,	Campbellton	N.B.
		Fort McMurray	A.
		Fort St.John	B.C.
		Leduc	A.
		Lunenburg	N.S.
		Medicine Hat	A.
		Orangeville	O.
		Prince George	B.C.
		Prince Rupert	B.C.
		Red Deer	A.
		Spruce Grove	A.
		Terrace	B.C.
XIB	III,IV,	St.Georges	Q.
		Victoriaville	Q.

Southern Ontario. Secondly, the concentration of economic activities within the urban system has shifted from the cities of Quebec and the South-East corner of Ontario, namely Ottawa-Hull, Montreal and Quebec, to the Toronto metropolitan area and Western Canada, particularly Edmonton and Calgary in Alberta. This trend should emerge even more clearly in the spatial distribution of cities having high factor scores on only one dimension.

This category of cities is shown on Figures 30. and 31. There are four Types of cities (i.e. Type XII, XIII, XIV, XV) with high scores on one dimension only (Table 22.). Each of these types labels a single economic dimension. Therefore, Type XIIA indexes cities characterized by high employment in the white-collar, tertiary sector of industry; Type XIIIA - cities characterized by high female employment, high employment in the secondary sector and high population change; Type XIVA - cities characterized by high service employment and Type XVA - cities characterized by high manufacturing employment (Table 22.1).

A closer examination of the spatial distribution of cities associated with one dimension only in 1971 (Figures 30.1 and 30.2), reveals that there is a strong regional correlation between the type of city and its distribution by provinces. For example, Type XIIIA is present in British Columbia, where there are eight cities ranking high on the second dimension, while Type XIIA occurs in the Prairie and Maritime Provinces (Figure 30.1). Cities of Quebec in turn are associated with Type XVA which occurs exclusively in this province. A relative mix of all four types of cities in Ontario (Figure 30.2), evidences even more the economic diversity of cities in this province.

The spatial distribution of Type XII to XV has changed in 1981, retaining the essential characteristics of the previous pattern. From Figure 31.1 and 31.2, it is clear that there is still a close correspondence between the economic types of cities and the provinces of Canada. This supports the hypothesis of the sharp differentiation of the cities located within or near major metropolitan areas. The noticeable change occurred also in Alberta where cities have high factor scores on more than one dimension, which suggests a much higher level of economic activity in 1981 than in 1971. This change suggests a significant economic development of cities in this

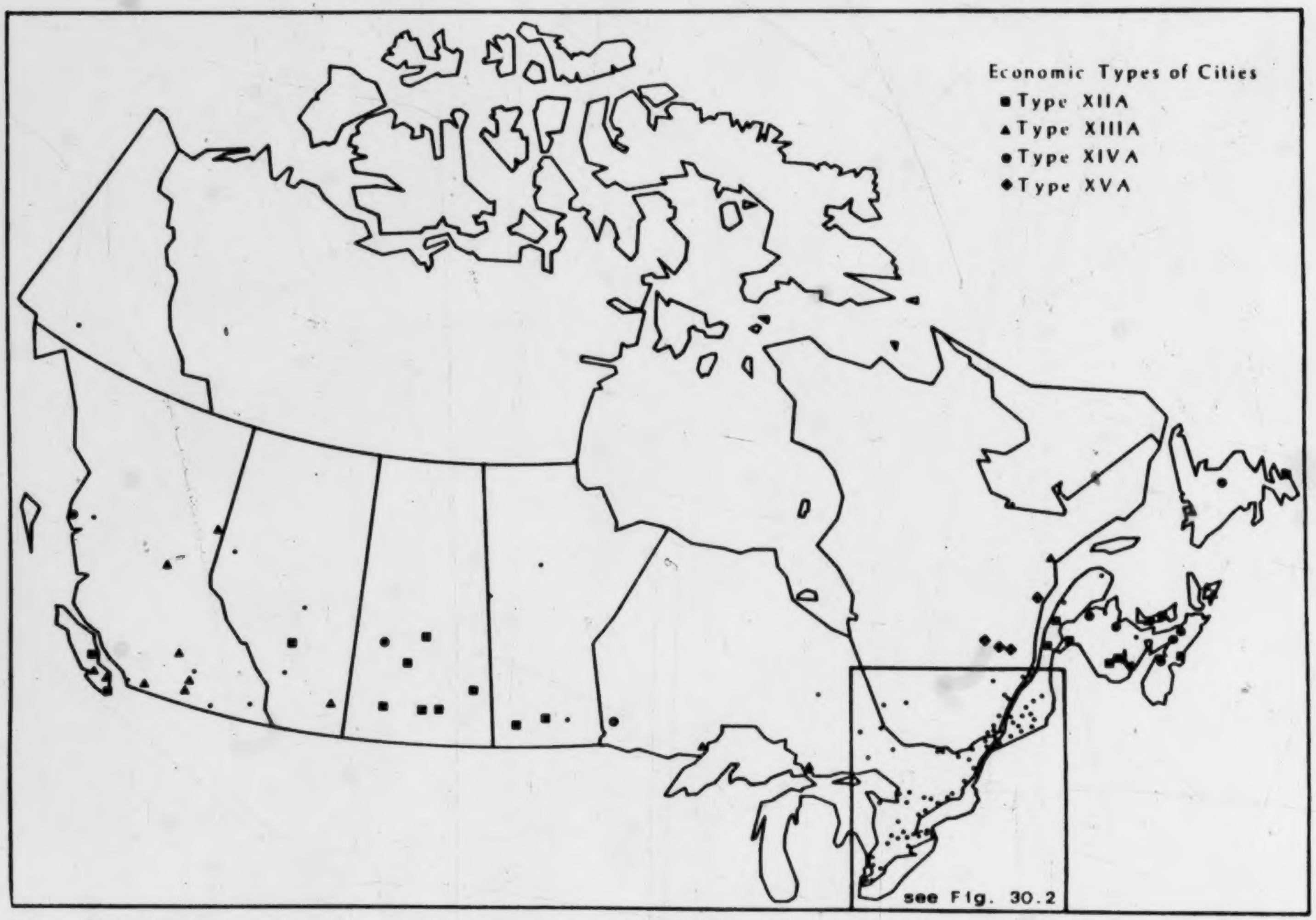

Economic Types of Cities
■ Type XIIA
▲ Type XIIIA
● Type XIVA
◆ Type XVA
see Fig. 30.2

Figure 30.1 1971 - Economic Types of Cities: Type XIIA, XIIIA, XIVA, XVA.

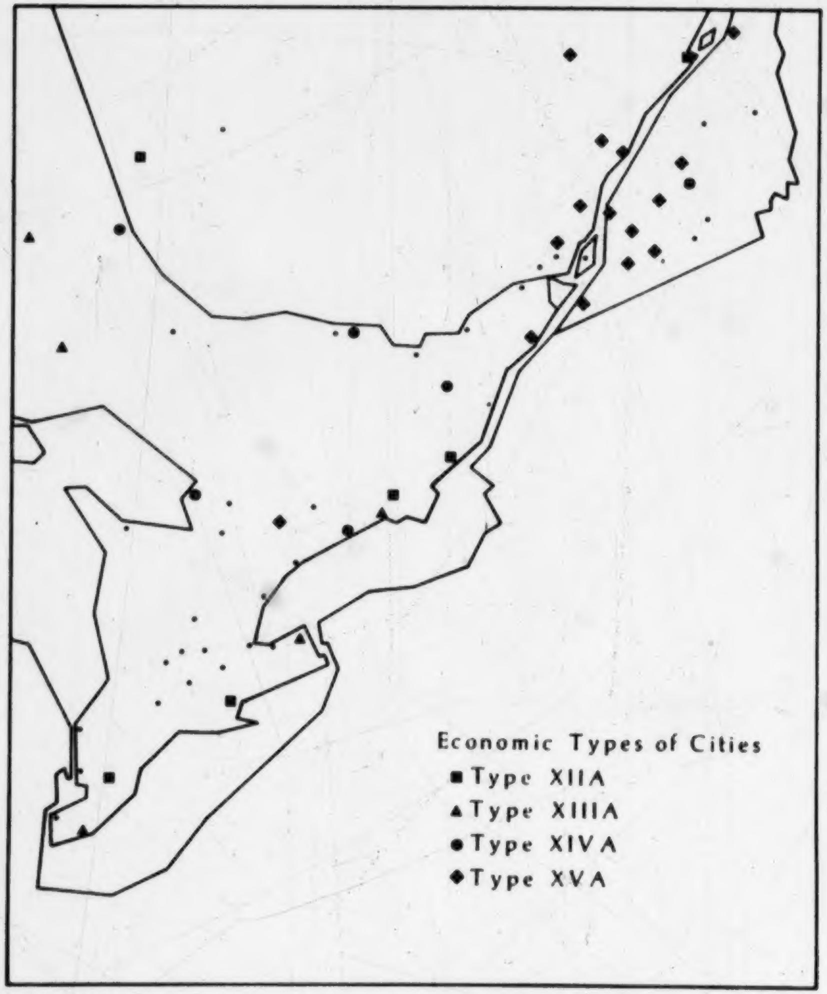

Economic Types of Cities
■Type XIIA
▲Type XIIIA
●Type XIVA
◆Type XVA

Figure 30.2 1971 - Economic Types of Cities: Type XIIA, XIIIA, XIVA, XVA.

Table 29. Economic Types of the Canadian Cities in 1971.
Type XIIA, XIIIA, XIVA, XVA.

Type	Dimensions	City	Province
XIIA	I,	Belleville	O.
		Brandon	M.
		Charlottetown	P.E.I.
		Chatham	O.
		Courtenay	B.C.
		Edmundston	N.B.
		Fredericton	N.B.
		Halifax	N.S.
		Kingston	O.
		Moose Jaw	S.
		Oromocto	N.B.
		Portage la Prairie	M.
		Prince Albert	S.
		Quebec	Q.
		Red Deer	A.
		Regina	S.
		Rimouski	Q.
		Riviere-du-Loup	Q.
		Rouyn	Q.
		Saskatoon	S.
		Simcoe	O.
		St.John's	Nfld.
		Swift Current	S.
		Victoria	B.C.
		Yorkton	S.
XIIIA	II,	Chilliwack	B.C.
		Corner Brook	Nfld.
		Dawson Creek	B.C.
		Kamloops	B.C.
		Kelowna	B.C.
		Leamington	O.
		Medicine Hat	A.
		Nanaimo	B.C.
		Penticton	B.C.
		Port Alberni	B.C.
		Prince George	B.C.
		Sarnia	O.
		Sault Ste.Marie	O.
		Sept-Iles	Q.
		St.Catharines-Niagara	O.
		Sudbury	O.
		Sydney	N.S.
		Sydney Mines	N.S.
		Thunder Bay	O.
		Timmins	O.
		Trenton	O.

Table 29. Economic Types of the Canadian Cities in 1971.
Type XIIA, XIIIA, XIVA, XVA (Continued)

Type	Dimensions	City	Province
XIVA	III,	Asbestos	Q.
		Campbellton	N.B.
		Cobourg	O.
		Grand Falls	Nfld.
		Haileybury	O.
		Kenora	O.
		Kentville	N.S.
		Midland	O.
		Newcastle	N.B.
		New Glasgow	N.S.
		Pembroke	O.
		Prince Rupert	B.C.
		Smiths Falls	O.
		Summerside	P.E.I.
		Truro	N.S.
XVA	IV,	Alma	Q.
		Baie-Comeau	Q.
		Chicoutimi-Jonquiere	Q.
		Cornwall	O.
		Dolbeau	Q.
		Drummondville	Q.
		Granby	Q.
		Joliette	Q.
		La Tuque	Q.
		Lindsay	O.
		Montmagny	Q.
		St.Hyacinthe	Q.
		St.Jean	Q.
		St.Jerome	Q.
		Shawinigan	Q.
		Sorel	Q.
		Trois-Rivieres	Q.
		Valleyfield	Q.
		Victoriaville	Q.

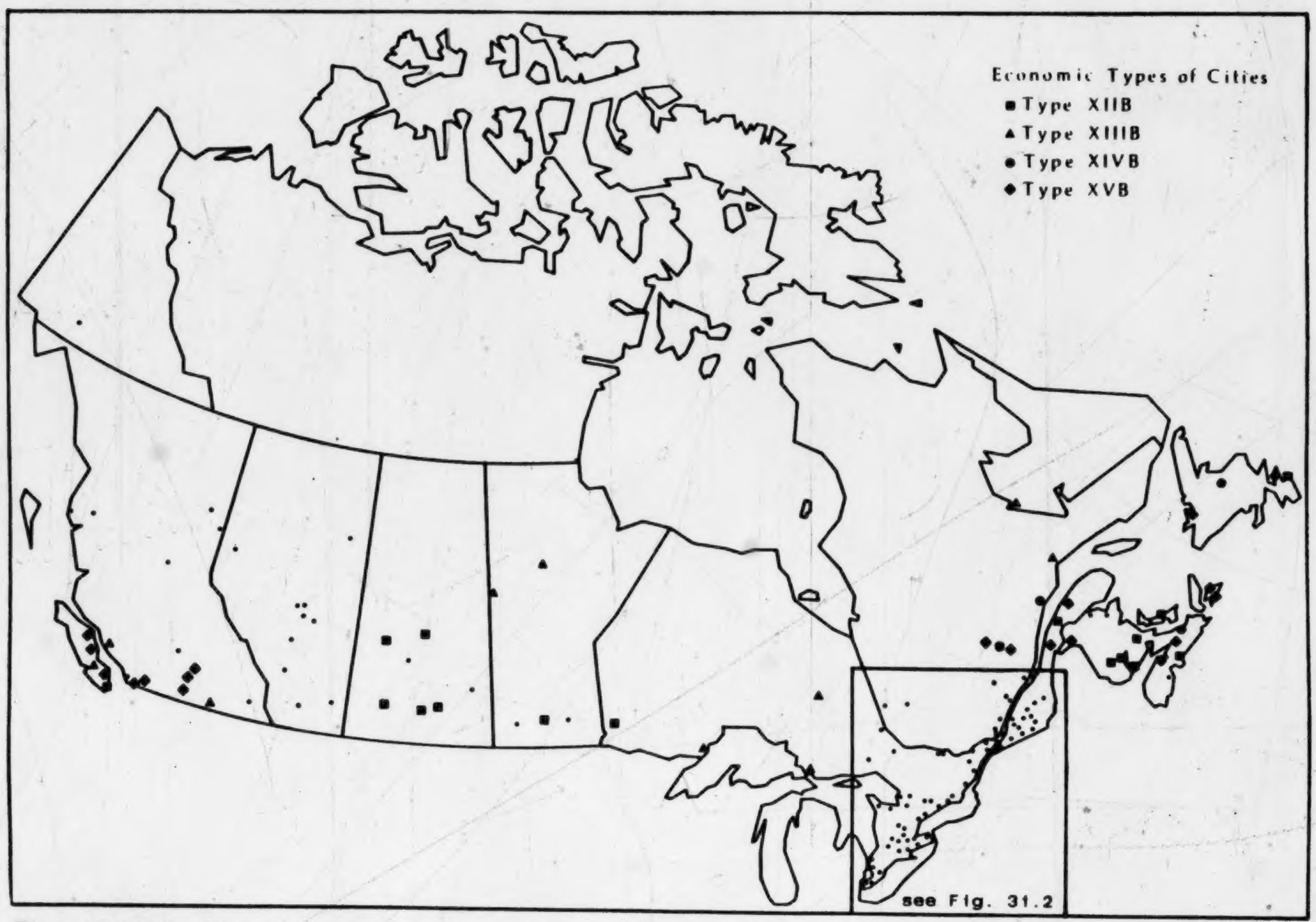

Economic Types of Cities
■ Type XIIB
▲ Type XIIIB
● Type XIVB
◆ Type XVB
see Fig. 31.2

Figure 31.1 1981 - Economic Types of Cities: Type XIIB, XIIIB, XIVB, XVB.

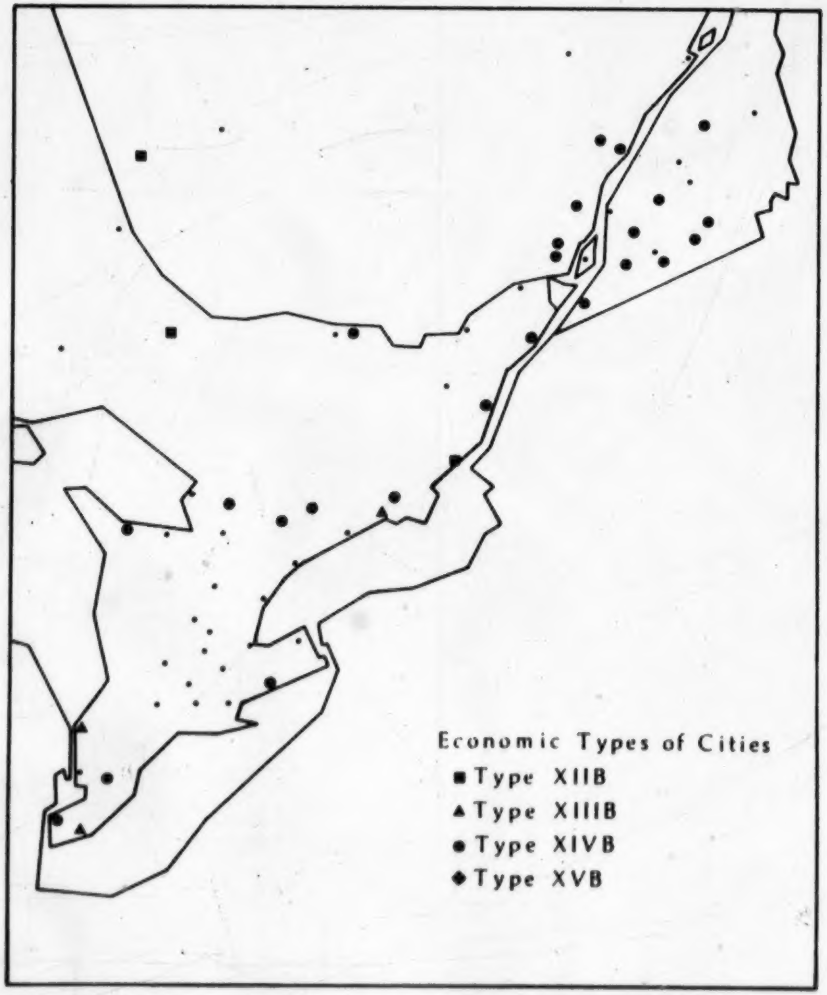

Economic Types of Cities
■ Type XIIB
▲ Type XIIIB
● Type XIVB
◆ Type XVB

Figure 31.2 1981 - Economic Types of Cities: Type XIIB, XIIIB, XIVB, XVB.

Table 30. Economic Types of the Canadian Cities in 1981. Type XIIB, XIIIB, XIVB, XVB.

Type	Dimensions	City	Province
XIIB	I,	Charlottetown	P.E.I.
		Fredericton	N.B.
		Halifax	N.S.
		Kenora	O.
		Kingston	O.
		Moncton	N.B.
		Moose Jaw	S.
		North Battleford	S.
		North Bay	O.
		Portage la Prairie	M.
		Prince Albert	S.
		Regina	S.
		Rimouski	Q.
		Rouyn	Q.
		Saint John	N.B.
		St.John's	Nfld.
		Swift Current	S.
		Victoria	B.C.
XIIIB	II,	Flin Flon	M.-S.
		Kapuskasing	O.
		Labrador City	Nfld.
		Leamington	O.
		Port Alberni	B.C.
		Powell River	B.C.
		Sarnia	O.
		Sault Ste.Marie	O.
		Sept-Iles	Q.
		Thompson	M.
		Thunder Bay	O.
		Trail	B.C.
		Trenton	O.
XIVB	III,	Alma	Q.
		Baie-Comeau	Q.
		Belleville	O.
		Brockville	O.
		Chatham	O.
		Cornwall	O.
		Cowansville	Q.
		Drummondville	Q.

Table 30. Economic Types of the Canadian Cities in 1981.
Type XIIB, XIIIB, XIVB, XVB (Continued)

Type	Dimensions	City	Province
XIVB	III,	Grand Falls	Nfld.
		Joliette	Q.
		Lachute	Q.
		Lindsay	O.
		Magog	Q.
		New Glasgow	N.S.
		Orillia	O.
		Owen Sound	O.
		Pembroke	O.
		Peterborough	O.
		St.Hyacinthe	Q.
		St.Jean	Q.
		St.Jerome	Q.
		Selkirk	O.
		Shawinigan	Q.
		Sherbrooke	Q.
		Thetford Mines	Q.
		Trois-Rivieres	Q.
		Valleyfield	Q.
		Windsor	O.
XVB	IV,	Abbotsford	B.C.
		Campbell River	B.C.
		Carbonear	Nfld.
		Chicoutimi-Jonquiere	Q.
		Chilliwack	B.C.
		Corner Brook	Nfld.
		Courtenay	B.C.
		Dolbeau	Q.
		Edmundston	N.B.
		Kelowna	B.C.
		Kentville	N.S.
		Matane	Q.
		Nanaimo	B.C.
		Penticton	O.
		Riviere-du-Loup	Q.
		Sydney	N.S.
		Sydney Mines	N.S.
		Truro	N.S.
		Vernon	B.C.

province over the ten year period 1971-1981. Another significant change occurred in Southern Ontario, particularly within or near the Toronto metropolitan area (Figure 31.2). Most of the cities located near Toronto have high factor scores on more than one dimension and do not fall into any of the types characterized by one economic dimension. This supports the hypothesis of progressive concentration of economic activities in this region. On the other hand, the spatial character of the distribution of urban centers in Quebec remained virtually unchanged over the ten year period concerned. Most of the cities, particularly within or near the Montreal metropolitan area, have significant factor scores on one dimension indicating a relatively stable character to this urban subsystem.

The significant findings concerning the spatial changes in the economic structure of the Canadian urban system can be summarized as follows. Firstly, there is a shift westward in the spatial distribution of the economically dynamic cities. Particularly meaningful is the decline in number of significant factor scores of cities such as Ottawa-Hull and Montreal and, at the same time, the increase in number of the high factor scores of cities such as Edmonton and Vancouver. This shift can be interpreted as a spatial manifestation of the change within the economic structure of the Canadian cities. This subject will be expanded in the last part of the chapter. Secondly, there is a very strong regional correspondence between the economic types of cities and their spatial distribution by provinces. More specifically, there is a sharp difference between cities located in Central , Maritime and Western Provinces as reflected in their economic dimensions. Cities of Southern Quebec, particularly around Montreal and Quebec City, tend to have high scores only on one dimension, whereas cities of Southern Ontario, particularly around Toronto, are characterized by much more diversified economic profiles. The most interesting change occurred in the Western Provinces, namely Alberta. The generally more diversified economic structure of cities in this province in 1981 as compared to 1971 indicates emergence of a new region of economic development (at least within the period under study), characterized by a high concentration of economic activity.

In the final section of this chapter, the spatial distribution of cities associated with the first dimension will be considered. The importance of this dimension lies in the fact, that this is the only dimension which did not change between 1971-1981. Therefore, a direct comparision of the distribution is possible. Moreover, it explains over 20% of the total variance in data matrices out of over 50% of the variance, which was possible to extract throughout the economic dimension model.

5.3 A Ranking of the Canadian Cities

Table 31., lists 124 cities in Canada which in 1971 and 1981 had over 10,000 inhabitants. The cities were ranked according to their factor scores on the first dimension in 1981. The table also shows their respective factor scores in 1971 as well as the rank on the 1971 factor score scale. Additionally, the difference between 1981 and 1971 factor scores is given.

The rank on the factor score scale indexes the relative position of a particular city to the rest of the cities in terms of the first dimension. The respective factor scores indicate an absolute position of the particular city on the first factor.

As was said already, the first dimension, white-collar tertiary employment , indexes a very strong trend in the Canadian urban system towards an urban concentration (in particular, service employment). Therefore, cities which rank higher in 1981 than in 1971 on the factor score scale can be considered as centers of concentration of the economic activity within the Canadian urban system. Possible clusters of such cities will indicate the economic growth areas of the system. Consequently, cities which rank lower in 1981 than in 1971, on the same scale, will indicate static or deconcentrating urban centers in terms of their economic activity. Analogously, the clusters of those cities will indicate static or deconcentration areas within the system. The aggregate results of cities examined in such a way are shown on Figure 32.1 and 32.2.

The city with the highest factor score, both in 1981 and 1971 was Ottawa-Hull, which retained its dominant position in the Canadian urban sytem. The relative position of this city

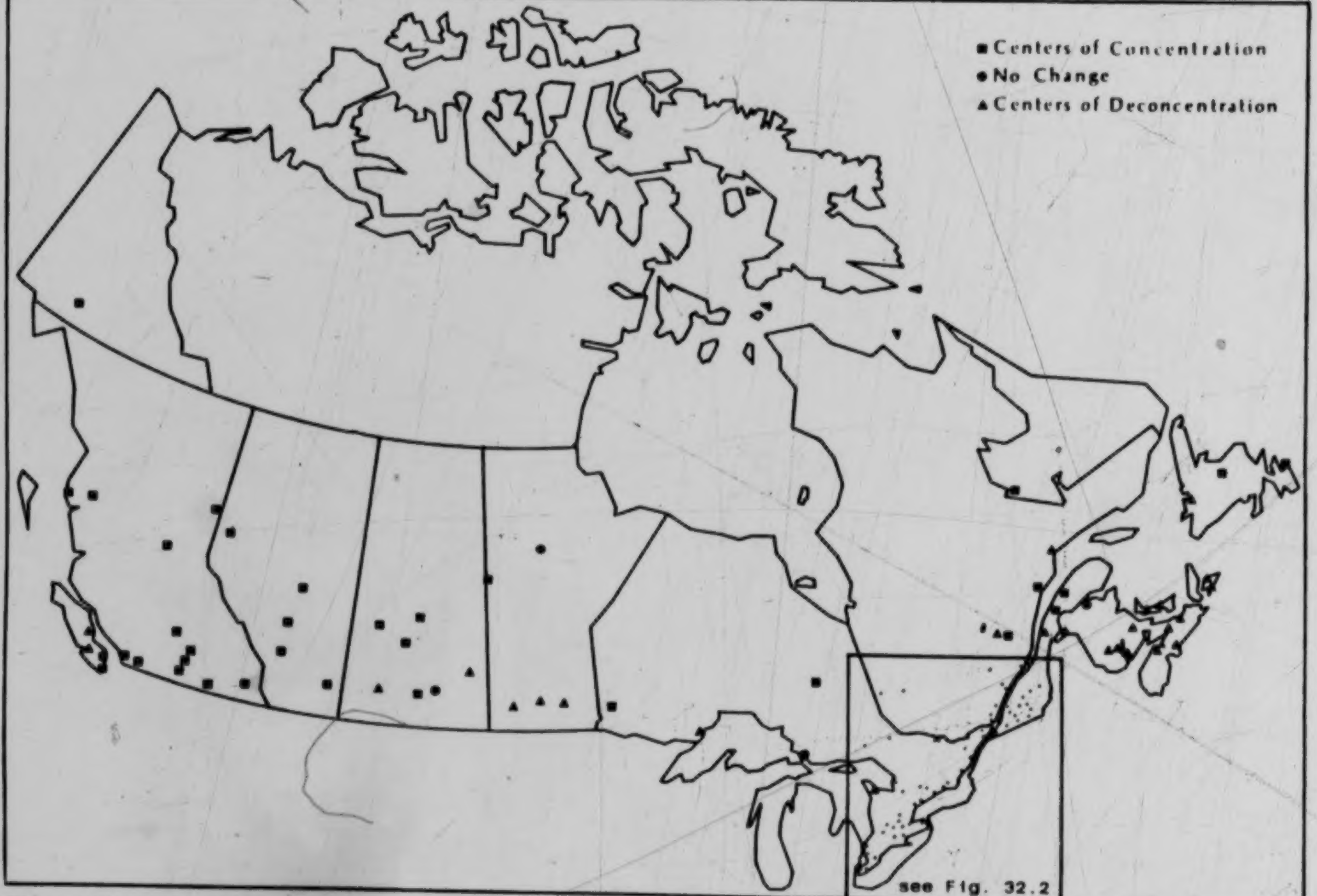

■ Centers of Concentration
● No Change
▲ Centers of Deconcentration
see Fig. 32.2

Figure 32.1 Centers of Concentration and Deconcentration of the Economic Activity in Canada: 1971-1981

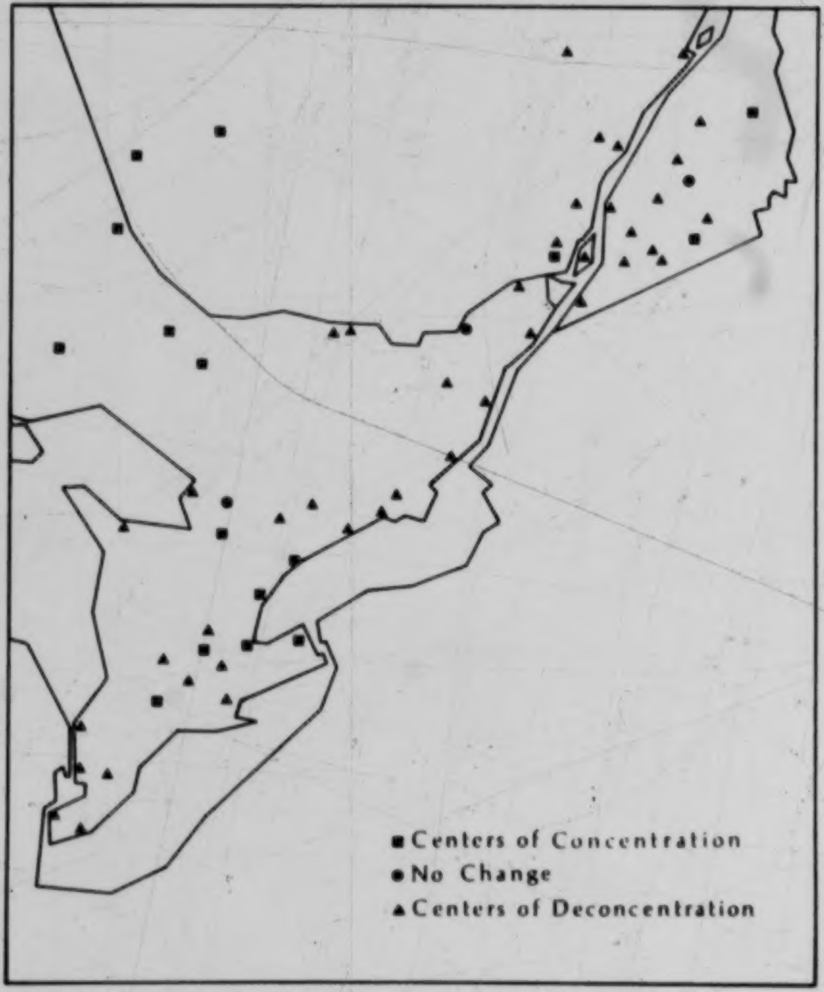

■ Centers of Concentration
● No Change
▲ Centers of Deconcentration

Figure 32.2 Centers of Concentration and Deconcentration of the Economic Activity in Canada: 1971-1981

Table 31. Ranking of the Canadian Cities 1971-1981.

Rank 1981	City	Province	F.Score 1981	F.Score 1971	Rank 1971	Difference 1971-1981
1	Ottawa-Hull	O.-Q.	2.72	2.53	1	+0.19
2	Calgary	A.	2.38	1.62	6	+0.76
3	Toronto	O.	2.17	1.79	4	+0.38
4	Whitehorse	Y.	2.02	0.71	35	+1.31
5	Regina	S.	1.97	1.75	5	+0.22
6	Edmonton	A.	1.66	1.25	13	+0.41
7	Red Deer	A.	1.64	1.27	11	+0.37
8	Halifax	N.S.	1.63	1.88	3	-0.25
9	Fredericton	N.B.	1.59	2.00	2	-0.41
10	Saskatoon	S.	1.52	1.18	15	+0.34
11	Vancouver	B.C.	1.51	0.92	26	+0.59
12	Quebec	Q.	1.50	1.48	7	-0.02
13	Rimouski	Q.	1.49	1.18	16	+0.31
14	Winnipeg	M.	1.47	1.31	10	+0.16
15	Victoria	B.C.	1.37	0.96	25	+0.41
16	Montreal	Q.	1.32	1.39	8	-0.07
17	St.John's	Nfld.	1.19	1.15	18	+0.04
18	London	O.	1.18	1.13	19	+0.05
19	Charlottetown	P.E.I.	1.13	1.21	14	-0.08
20	Grande Prairie	A.	1.08	0.85	30	+0.23
21	North Battleford	S.	1.07	0.89	27	+0.18
22	Yorkton	S.	0.93	1.16	17	-0.23
23	Swift Current	S.	0.82	1.07	22	-0.25
24	Kingston	O.	0.79	1.32	9	-0.53
25	Moncton	N.B.	0.78	1.08	21	-0.30
26	Prince Albert	S.	0.72	0.84	31	-0.12
27	Dawson Creek	B.C.	0.69	-0.08	73	+0.77
28	Cranbrook	B.C.	0.66	-0.07	70	+0.73
29	North Bay	O.	0.66	0.80	33	-0.14
30	Barrie	O.	0.62	0.61	39	+0.01
31	Kamloops	B.C.	0.60	0.23	53	+0.37
32	Kenora	O.	0.56	-0.49	95	+1.05
33	Rouyn	Q.	0.53	0.12	63	+0.41
34	Smiths Falls	O.	0.51	-0.37	88	+0.88
35	Brandon	M.	0.51	1.08	21	-0.57
36	Moose Jaw	S.	0.46	0.56	42	-0.10
37	Orillia	O.	0.45	0.62	37	-0.17
38	Sherbrooke	Q.	0.44	0.87	29	-0.43
39	Portage la Prairie	M.	0.43	0.96	24	-0.53
40	Guelph	O.	0.42	0.83	32	-0.41
41	Peterborough	O.	0.38	0.88	28	-0.50
42	Saint John	N.B.	0.37	0.57	41	-0.20
43	Simcoe	O.	0.36	0.62	38	-0.26
44	Prince George	B.C.	0.32	-0.10	74	+0.42
45	St.Catharines- -Niagara	O.	0.31	-0.16	75	+0.47

Table 31. Ranking of the Canadian Cities 1971-1981 (Continued)

Rank 1981	City	Province	F.Score 1981	F.Score 1971	Rank 1971	Difference 1971-1981
46	Belleville	O.	0.29	0.99	23	-0.70
47	Owen Sound	O.	0.29	0.63	36	-0.34
48	Val d'Or	Q.	0.23	-0.80	105	+1.03
49	Kitchener	O.	0.23	0.005	67	+0.22
50	Hamilton	O.	0.22	0.21	54	+0.01
51	Brockville	O.	0.21	1.26	12	-1.05
52	Kelowna	B.C.	0.15	-0.06	69	+0.21
53	Oshawa	O.	0.14	0.20	57	-0.06
54	Nanaimo	B.C.	0.13	-0.31	85	+0.44
55	Thompson	M.	0.13	0.21	55	-0.08
56	Penticton	B.C.	0.08	-0.25	82	+0.33
57	Medicine Hat	A.	0.07	-0.31	84	+0.38
58	Vernon	B.C.	0.06	0.13	62	-0.07
59	Bathurst	N.B.	0.06	0.39	46	-0.33
60	Riviere-du-Loup	Q.	0.04	0.71	34	-0.67
61	Oromocto	N.B.	0.03	0.60	40	-0.57
62	Chatham	O.	-0.006	0.54	43	-0.55
63	Matane	Q.	-0.05	0.02	66	-0.07
64	Thunder Bay	O.	-0.06	0.15	60	-0.21
65	Stratford	O.	-0.06	0.30	50	-0.36
66	St.Georges	Q.	-0.07	-0.39	90	+0.32
67	Haileybury	O.	-0.10	-0.63	99	+0.53
68	Kentville	N.S.	-0.10	0.47	44	-0.57
69	Lindsay	O.	-0.14	0.38	47	-0.52
70	Joliette	Q.	-0.16	0.43	45	-0.59
71	Sarnia	O.	-0.17	0.31	49	-0.48
72	Sudbury	O.	-0.20	-0.42	91	+0.22
73	Chilliwack	B.C.	-0.23	-0.44	92	+0.21
74	Summerside	P.E.I.	-0.23	0.14	61	-0.37
75	Courtenay	B.C.	-0.27	0.07	64	-0.34
76	Woodstock	O.	-0.31	0.27	51	-0.58
77	St.Hyacinthe	Q.	-0.32	0.15	59	-0.47
78	Pembroke	O.	-0.33	0.24	52	-0.57
79	Baie-Comeau	Q.	-0.33	-0.79	103	+0.46
80	Campbellton	N.B.	-0.33	-0.23	80	-0.10
81	Brantford	O.	-0.36	-0.07	72	-0.29
82	St.Jerome	Q.	-0.37	-0.25	81	-0.12
83	Windsor	O.	-0.37	0.18	58	-0.55
84	St.Jean	Q.	-0.41	-0.16	76	-0.25
85	Trois-Rivieres	Q.	-0.41	-0.16	78	-0.22
86	Victoriaville	Q.	-0.42	0.34	48	-0.76
87	Trail	B.C.	-0.46	-1.46	116	+1.00
88	Corner Brook	Nfld.	-0.47	-0.30	83	-0.17
89	Edmundston	N.B.	-0.47	0.20	56	-0.67
90	Truro	N.S.	-0.49	-0.37	89	-0.12

Table 31. Ranking of the Canadian Cities 1971-1981 (Continued)

Rank 1981	City	Province	F.Score 1981	F.Score 1971	Rank 1971	Difference 1971-1981
91	Chicoutimi-Jonquiere	Q.	-0.51	-0.46	94	-0.05
92	Cobourg	O.	-0.52	-0.32	86	-0.20
93	Grand Falls	Nfld.	-0.62	-0.74	102	+0.12
94	Sept Iles	Q.	-0.63	-0.07	71	-0.56
95	Trenton	O.	-0.67	-0.01	68	-0.66
96	Sault Ste.Marie	O.	-0.67	-0.51	96	-0.16
97	Cornwall	O.	-0.74	-0.20	79	-0.54
98	Terrace	B.C.	-0.76	-1.04	109	+0.28
99	Thetford Mines	Q.	-0.78	-0.36	87	-0.42
100	Petawawa	O.	-0.79	0.04	65	-0.83
101	Kapuskasing	O.	-0.79	-1.32	114	+0.53
102	Alma	Q.	-0.82	-0.16	77	-0.66
103	Drummondville	Q.	-0.92	-0.71	101	-0.21
104	Granby	Q.	-0.95	-0.54	97	-0.41
105	Flin Flon	M.-S.	-1.00	-2.28	122	+1.28
106	Prince Rupert	B.C.	-1.02	-1.25	113	+0.23
107	Cowansville	Q.	-1.03	-0.64	100	-0.39
108	Midland	O.	-1.06	-0.88	107	-0.18
109	Leamington	O.	-1.08	-0.79	104	-0.29
110	Sydney	N.S.	-1.10	-0.81	106	-0.29
111	New Glasgow	N.S.	-1.13	-0.44	93	-0.69
112	Valleyfield	Q.	-1.18	-0.95	108	-0.23
113	Magog	Q.	-1.25	-1.61	117	+0.36
114	Lachute	Q.	-1.44	-1.65	118	+0.21
115	Labrador City	Nfld.	-1.57	-2.47	123	+0.90
116	Wallaceburg	O.	-1.57	-1.16	111	-0.41
117	Dolbeau	Q.	-1.58	-1.77	120	+0.19
118	Sorel	Q.	-1.59	-0.58	98	-1.01
119	Shawinigan	Q.	-1.63	-1.16	112	-0.47
120	La Tuque	Q.	-1.63	-1.09	110	-0.54
121	Hawkesbury	O.-Q.	-1.68	-1.71	119	+0.03
122	Sydney Mines	N.S.	-1.78	-1.38	115	-0.40
123	Port Alberni	B.C.	-1.91	-1.96	121	+0.05
124	Asbestos	Q.	-2.24	-2.65	124	+0.41

on the factor score scale did not change between 1971 and 1981. However, the absolute magnitude of the factor scores has increased by +0.19 during this period (Table 31.). Also the lowest ranking city - Asbestos - did not change its position on the factor score scales. Still, its factor score increased by +0.41.

There were at least four regions in the country in 1981 which can be associated with the concentration areas wthin the system (Figure 32.). The first one, and the largest one, can be broadly defined as Western Canada, including British Columbia, Alberta, the central part of Saskatchewan and Northern Manitoba. Almost all cities of the region uniformly (except for the northern part of Vancouver Island) experienced a concentration of economic activities. Particularly, Vancouver - Victoria and the Edmonton - Calgary metropolitan areas, emerged as the new concentration areas within the Canadian urban system. The second region can be identified with the central part of Ontario - Kapuskasing, Sudbury, North Bay and western part of Quebec - Rouyn and Val d'Or. The third region, associated with the process of economic concentration, is the Toronto metropolitan area. The city itself ranks as the third one with the highest factor score in 1981 (Table 31.). There are six other cities within or near metropolitan Toronto, which had higher factor scores in 1981 than in 1971 - Oshawa, Hamilton, St.Catharines-Niagara, Kitchener, London and Barrie. This close association of a large metropolitan area with the process of urban concentration in the surrounding areas can be accounted for by the metropolitanization process described in more detail in the previous part of this chapter. The fourth region described as the economic concentration area is much less consistent than the previous three. It can be defined as including the north-eastern part of Quebec along the St.Lawrence River and Newfoundland (Figure 32.).

The rest of the cities in the Maritime Provinces had factor scores in 1981 below their respective level in 1971. Therefore, the Maritime Provinces, except Newfoundland, can be grouped as the first area of economic deconcentration within the Canadian urban system. The second one consists of the Montreal metropolitan area and all but three - St.Georges, Magog and Lachute - cities in Southern Quebec. This region is closely interrelated with the rest of the industrial heartland of Canada, i.e. Southern Ontario, which forms the third deconcentration area.

Interestingly, all the cities in the heartland of Canada except the Toronto metropolitan area experienced deconcentration of economic activity, especially in terms of tertiary employment. The fourth and last, area of the economic deconcentration in Canada is associated with the southern part of Manitoba and Saskatchewan, except Regina (Figure 28.). This is the only region within the Prairie Provinces where cities ranked lower on 1981 factor scale than in 1971.

VI. CONCLUSIONS

The major objective of this thesis as outlined in Chapter One was to describe and examine the Canadian urban system through the analysis of the economic structures of all urban places of over 10,000 inhabitants in Canada. This examination focused on the changes to the economic dimensions associated with the cities of this system between 1971 and 1981. To achieve this aim, demographic, labor force and employment variables at the two points in time were examined for each urban place by means of the principal-component technique. Then, factor loadings extracted from the data matrices were interpreted in order to determine the basic economic dimension of the Canadian urban system at each time period. A comparision of the economic dimensions in 1971 with the economic dimensions in 1981 enabled the isolation of the structural changes in the dimensions of the Canadian urban system as a whole. The results of this part of the analysis were related to the first hypothesis outlined in Chapter One, concerning the dynamics of the Canadian urban system in the ten year period 1971-1981. The hypothesis states that if the Canadian urban system is evolving towards the progressive concentration of economic activities in its major urban centers, the economic dimensions indicating the process of metropolitanization should yield stronger factor loadings in the factor matrix. Particularly, variables indexing tertiary, service, transportation and communication employment should emerge more clearly in the 1981 factor matrix. Also the overall economic stratification, that is, the number of significant loadings for different sectors of employment should increase in 1981 as compared to 1971. Moreover, cities located within or near metropolitan areas should have much higher factor scores on the dimensions indicating metropolitanization than cities located outside these areas.

The next step involved preparation of an economic typology of Canadian cities, based on their factor scores on the economic dimensions. The resulting groups of cities were mapped according to these economic types. By comparing the spatial distribution of the economic types of cities between 1971 and 1981, conclusions about the spatial direction of change within the Canadian urban system were drawn. This stage of the analysis relates to the second hypothesis concerned with the spatial changes in the economic dimensions of the system. That is, even if the economic dimensions do not change over time significantly, indeed proving the relatively stationary character of the Canadian urban system, the factor scores of the individual urban places may vary considerably from one period to another. Therefore, the relative position on the factor score scale will reflect a change in the economic structure of the cities concerned.

The final step consists of detailed comparision of the cities on the first dimension in 1971 and 1981. This dimension indexes a trend towards economic concentration in the system. An examination of the factor scores on this dimension enabled the determining of certain subsystems of cities defined either by concentration or deconcentration (or stability) of the economic activities the towns perform.

6.1 The Findings: Summary of Results

In 1971, the major economic dimensions of the Canadian urban system were identified as:

1. White-collar, service-administrative character of metropolitan centers of Canada.
2. High female employment in manufacturing and low unemployment in the secondary sector.
3. Frontier-service centers.
4. Specialized manufacturing centers.

In 1981 the dimensions were identified as:

1. Metropolitan, white-collar, service-administrative character of the major urban centers of Canada.
2. High labor force participation ratio in manufacturing.
3. Manufacturing centers of the industrial heartland of Canada.
4. High rate of the population change associated with high employment in sales and construction sectors.

The first dimension showed a considerable degree of stability of the Canadian urban system. It indexes a trend within the system towards an increasing significance of the tertiary, particularly service, employment in the economic structure of the Canadian cities. The remaining three dimensions have changed over time reflecting a structural change of the system over time. The most significant change can be noted in manufacturing employment. The relative importance of it has increased as shown by the emergence of the two dimensions in 1981 (the second and third), related to this sector of industry. At the same time, there was a decline in the relative importance of the frontier-service dimension, which is not present in 1981 analysis.

The dynamics of the dimensions, that is, their changes over the ten year period 1971-1981, were examined in two ways. Firstly, the loadings of the dimensions were compared. Secondly, the spatial distribution of the economic types of cities based on the typology defined according to the economic dimensions was examined.

The first method relates to the first hypothesis concerned with the dynamics of the dimensions themselves. Most of the approaches which were reviewed in Chapter One of the thesis implied, either directly or indirectly, an evolution of the Canadian urban system as a whole. Therefore, the dimensions which index the most important aspects of the system's economy should change over time as well. However, the examination of the dimensions in 1971 and 1981 showed that the economic dimensions of the Canadian urban system remained partially stable, contradicting much of what is already known concerning the dynamics of urban systems. Particularly, the first dimension, i.e. in 1971 - white-collar, service -administrative character of metropolitan centers of Canada - appeared even stronger in 1981 analysis, suggesting an increasing role of the service employment in the Canadian economy. The remaining three dimensions have changed over time, retaining, however, some similarities to each other in both analyses. Particularly, the relative importance of population change and female employment has decreased, while the significance of the participation rate and manufacturing employment has increased.

The stability of the system, as reflected by the first dimension, required closer examination. According to the first hypothesis, if the Canadian urban system is evolving towards progressive urban concentration of economic activities in its major urban centers, the factor analysis will yield stronger factor loadings on the variables indicating this process. That is, the variables indexing tertiary, service, transportation and communication employment should emerge more clearly in the 1981 factor matrix. Since the first dimension in 1971 and in 1981 indexed white-collar tertiary employment (and factor loadings on this dimension in 1981 were indeed stronger than in 1971), it can be concluded that the first dimension indicates a very strong trend towards concentration of the economic activities, particularly service employment, in the major urban centers of the system. Moreover, the increase in the relative significance of manufacturing employment, as indicated by the changes in the remaining three dimensions, implies progressive economic diversification of the urban centers in Canada. In particular, the emergence of the two (i.e. the second and third) dimensions in 1981, indexing manufacturing employment, confirm the above conclusion.

To summarize, the analysis of the economic dimensions of the Canadian urban system revealed that they remained partially stable between 1971 and 1981. Particularly, the first dimension - white-collar, tertiary employment - accounting for 20.9% of the variance in the data matrix - remained the same in both analyses. A closer examination revealed that the dimensions indexed a process of urban concentration and progressive economic diversification of the Canadian cities, particularly in the industrial heartland and the Prairie Provinces. In other words, there is very strong evidence that the economic dimensions of the Canadian urban system were much less dynamic than was suggested in the geographic literature (eg. King, 1966). Such a conclusion implies a static or at least much less dynamic character of the economic changes within the system. However, when the dynamics of the system is considered by means of changes in the geographic space the conclusion is quite different.

The second hypothesis states that the distribution of the economic dimensions of the employment profiles of the Canadian cities may change even if the major economic dimensions remain the same. The findings in this thesis allow the acceptance of the hypothesis. Firstly, there is a trend towards the concentration of the economic activities in larger i.e. metropolitan areas. This phenomenon can account for the significant decline in the number of small urban centers within the Canadian urban system discussed in the second chapter. Secondly, there is a process of progressive economic diversification of the Canadian cities, particularly with reference to manufacturing activity.

The significant findings concerning the changes in the economic structure of the Canadian urban system in geographic space can be summarized as follows. Firstly, there was a shift westward in the spatial distribution of the most diversified cities. In particular, it is significant that there was a decline in the number of high factor scores of cities such as Ottawa-Hull and Montreal and at the same time an increase in the number of the high factor scores of cities such as Edmonton and Vancouver. This shift can be interpreted as a spatial manifestation of the changes in the distribution of metropolitan growth areas in Canada, that is, the decline in the economic importance of the large cities located in the Canada's heartland (eg. Montreal) and an increase of the economic activity of the large cities in the Prairie Provinces (eg. Edmonton, Calgary).

Secondly, there is a very strong regional association of particular types of cities, as defined in Chapter Five, with their distribution in geographical space. More specifically, there is a sharp economic contrast between cities located in the Central, Maritime and Western Provices, as reflected in their economic dimensions. Cities of Southern Quebec, particularly those around Monteral and Quebec City, tend to have high scores only on one dimension, indicating a highly specialized economic structure, whereas cities of Southern Ontario, particularly around Toronto, are characterized by much more diversified economic profiles. Such a pattern can be interpreted as indicating an economic shift within the Quebec-Ontario urban subsytem. However, the most important change to note occurred in the Western Provinces, especially Alberta. The generally more diversified economic structure of cities in this province in 1981, as compared to 1971, indicates the emergence of a new economic growth area characterized by a high concentration of economic activity (at least at that point in time).

All of the findings account for a substantial economic shift within the Canadian urban system between 1971 and 1981, even though the major economic dimensions of this system showed a much lesser degree of dynamics. In particular, the spatial change in the distribution of employment profiles within the system is noticeable. However, the study revealed the major deficiency of the urban systems approach, which is the lack of a well-defined framework for empirical investigation. This subject will be elaborated on in the following paragraphs of the chapter.

6.2 Implications for Further Research

There are three groups of recommendations for future research. The first one is a further consideration and improvement of the conceptual framework in urban systems research. The second are practical suggestions for the selection of variables and the time framework. The third one relates to the method of the study, that is, the factor analysis.

Given the distinctly geographical character of the research in the area of the urban systems, it is surprising that, until very recently, geographers have given very little attention to the subject of the evolution of urban systems over time. Whether the cause was the heavy emphasis on intra-urban analysis (eg. inner-city structure) or the difficulties of collecting data of a complete and comparable nature in the past is unclear (Smith, 1982). What is important, however, is that there were very few attempts at analysis on aggregate scale. Therefore, not surpraizingly, as Pred pointed out:

> " At present the state of knowledge relating to the processes that generate metropolitan concentration and interregional economic and social inequalities must be regarded as little more than primitive. Moreover, the factors influencing the growth and development of economically advanced city-systems are so numerous and complex that, in all likelihood, they prohibit a complete and definitive modelling of their operations" (Pred, 1977, p.12).

There appear to be several reasons why geographers have failed to explore the urban system research in urban geography. Perhaps, the most important of them is that within urban geography the focus of study has been on the urban places as *areas* (except Central Place Theory) with an internal structures rather than on the urban places as points in geographical space comprising the urban system on an national or regional scale. Additionally, many urban geographers have neglected the time dimension in their studies of urban phenomena. Pattern and distribution, not process, have received the most attention. Therefore, the research in the area of the urban systems has to focus on dynamic models of the urban phenomena.

The time dimension variable introduces the second broad group of suggestions for future research. Many of the findings of this thesis, particularly the relatively stable character of the economic dimensions, have to be considered cautiously. The relatively short time framework for the study may account for a large proportion of this stability. However, the testing of any hypothesis will require a study based on a much longer time frame, preferrably fifty or more years. Also, selection of the variables to be included in an analysis deserves serious attention. The relatively small proportion of the total explanation of the factor solution in this thesis can be accounted for by the lack of social variables in the data matrix. This thesis has focused upon the major economic changes within the Canadian urban system and within this objective it fulfilled its goal. However, in order to improve the degree of explanation of the factor technique applied here, a careful selection of some social characteristics would be required. This selection must be based on a properly and specifically defined theoretical framework to avoid the deficiencies of the past factorial studies, which simply used all available data in order to determine the most significant among them.

The third group of recommendations refers to the factor analysis technique employed in this thesis. The research design of the study includes a standard factor technique which generates a factor matrix of variables correlated among themselves and factor scores of areal units associated with the variables. This technique is known as R-mode of the factor analysis. However, there are several other factorial designs available, which make it possible to transpose the data matrix in such a way that the areal units of the analysis can be correlated among themselves rather than the variables describing them i.e. Q-mode. For example, if the correlation of variables produces a factor of high significance in tertiary activities, the Q-technique will show areas with areal differentiation on that activity. The R- and Q-techniques are very useful for showing changes over time. There is, however, another algorithm i.e. M-mode, which involves the running of like (or possibly different) matrices for several time periods simultaneously. This letter method has been little used, if at all, in the studies of urban and economic development. The R-, Q- and M- techniques, then, provide the means of testing three kinds of hypotheses related to urban systems development, as suggested by Megee (1975, p.219):

1. R- can test hypotheses about variables causing economic change, using the factor loadings and factor scores.
2. Q- can test hypotheses regarding the areal differentiation of patterns of urban development using the factor scores alone.
3. M- can test hypotheses involving changes of variables or regions over long periods.

Therefore, the best factorial design for the future research on the evolution of the urban system over time is M-mode factor analysis.

Although the study in this thesis was designed primarily towards an empirical analysis of the Canadian urban system, some practical recommendations were possible. However, the major success of it is that several basic aspects of the Canadian urban system were found. It is hoped that some of the results in this thesis will help in understanding the complex processes occurring within the Canadian urban system and thereby, open the way for a detailed examination of particular changes in particular parts of the system.

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APPENDIX 1. 1971 AND 1981 DATA MATRICES

1971 DATA MATRIX (For explanation of codes see Table 4., pp.35,36)

NAME	POP1	CH2	M3	M4	M5	F8	F9	F10	ALL13	R14	R15	R16	R17	R18	R19	R20	R21
ALMA	22622	2.0	4945	66.7	16.5	2140	28.3	18.7	5800	2.4	5.1	2.4	1.0	0.3	9.7	4.7	1.2
ARNPRIOR	10089	3.3	2850	79.8	8.2	1500	41.7	5.7	4260	1.8	2.8	1.2	0.6	0.2	3.8	2.2	3.3
ASBESTOS	15674	-4.1	3940	70.9	9.0	1435	26.4	15.3	5120	2.8	2.6	1.2	0.6	0.3	4.8	2.2	3.8
BAIE-COMMEAU	25290	7.1	6485	78.9	9.1	2615	33.7	14.5	8690	2.6	3.7	2.2	0.9	0.2	5.6	3.9	0.6
BARRIE	38176	19.8	10485	78.9	6.0	5925	42.2	9.5	16135	1.8	4.4	1.6	0.8	0.2	4.3	4.0	0.8
BATHURST	16674	9.3	4305	76.3	7.8	2060	36.6	8.8	6250	2.1	4.8	4.3	1.0	0.7	5.0	3.9	0.4
BRANDON	31150	3.9	8515	76.6	6.6	5430	44.6	6.9	13715	1.5	3.4	1.7	1.2	0.4	4.6	8.0	0.9
BRANTFORD	80284	6.8	22630	79.4	7.3	13525	45.1	9.9	35610	1.7	3.6	1.8	0.7	0.2	3.0	4.1	1.0
BROCKVILLE	19765	2.6	5475	81.2	5.2	3635	47.1	6.7	8980	1.5	4.2	4.3	0.9	0.2	4.0	6.3	0.7
CALGARY	403319	22.0	114975	82.9	6.6	66085	46.6	8.9	177830	1.8	5.8	5.1	1.1	0.2	3.9	4.0	1.0
CAMPBELLTON	12443	-0.2	2745	67.8	12.4	1735	38.5	8.6	4385	1.6	2.5	1.7	0.7	0.2	6.3	10.5	4.7
CHARLOTTETOWN	25253	10.1	6410	76.4	6.5	4385	44.0	8.3	10595	1.5	5.2	3.1	1.4	0.9	5.0	3.6	1.2
CHATHAM	35317	8.9	9580	78.8	7.9	5655	42.9	10.5	14940	1.7	3.8	2.3	1.0	0.3	3.9	5.9	0.6
CHICOUTIMI-JONQ.	133703	0.6	29890	66.6	14.8	12785	28.1	15.6	39665	2.4	3.3	2.7	1.1	0.4	7.0	4.2	1.0
CHILLIWACK	33322	14.7	9085	75.3	8.3	4405	37.5	11.8	13155	2.1	2.5	1.0	0.7	0.2	3.6	2.7	0.3
COBOURG	18316	4.6	4925	79.3	6.8	2865	41.3	10.6	7610	1.7	4.4	3.7	1.0	0.7	3.9	4.9	4.4
CORNER BROOK	26309	-3.0	6400	74.0	9.3	2915	33.4	8.7	9065	2.2	3.5	1.7	0.4	0.3	4.2	5.2	0.9
CORNWALL	47116	2.9	12025	74.5	10.3	6890	39.5	11.5	18285	1.7	3.2	2.6	0.7	0.3	4.4	5.3	0.7
COURTENAY	16166	21.5	4560	81.6	7.2	1960	36.6	15.1	6260	2.5	1.8	3.5	1.0	0.6	4.3	3.7	2.9
COWANSVILLE	11920	11.5	2880	65.8	7.7	1440	36.0	10.8	4160	2.0	3.8	1.4	0.7	0.2	4.2	3.1	0.7
CRANBROOK	12000	52.9	3450	82.0	6.9	1600	40.6	10.3	4965	2.2	3.2	2.3	0.6	0.2	2.5	3.3	0.8
DAWSON CREEK	11885	-4.1	3075	79.2	12.0	1765	46.5	10.8	4705	1.8	3.0	1.1	0.7	0.4	5.1	3.4	0.9
DOLBEAU	11234	-1.3	2310	63.4	19.5	1065	28.7	13.6	3155	2.2	3.0	1.4	0.5	0.2	7.6	3.2	2.5
DRUMMONDVILLE	46524	0.7	11745	71.9	11.7	6205	36.2	15.1	17160	1.9	4.0	2.0	0.7	0.2	4.7	3.2	0.8
EDMONTON	495702	16.5	140155	82.1	7.0	82360	47.6	7.9	218770	1.7	4.6	3.6	1.2	0.2	4.5	4.8	0.9
EDMUNDSTON	12365	-1.2	2945	68.5	9.6	1645	35.0	9.5	4411	1.8	3.7	2.0	0.7	1.1	5.9	6.1	1.1
FLIN FLON	11201	-6.0	3150	77.4	27.6	1215	32.2	13.6	4300	2.6	2.0	1.3	0.7	0.3	3.6	3.4	5.8
FREDERICTON	37684	12.2	10715	81.5	6.5	6460	45.6	6.7	16935	1.7	6.1	5.8	1.5	0.4	6.0	3.7	1.4
GASPE	17211	99.9	3865	65.9	15.2	1880	33.6	13.4	5430	2.1	2.3	1.2	1.0	0.4	6.3	6.8	0.7
GRANBY	39307	-0.4	9685	72.1	10.3	5440	38.7	15.1	14600	1.8	3.9	1.7	0.8	0.2	4.1	1.8	0.8
GRAND FALLS	14321	1.3	3270	73.5	9.2	1445	31.3	6.6	4035	2.3	3.9	1.3	0.5	0.3	5.8	5.0	3.3
GRANDE PRAIRIE	13079	14.6	3685	82.9	5.5	2075	48.0	6.9	5675	1.8	4.1	2.3	1.4	0.3	4.2	5.0	0.3
GUELPH	62659	16.7	17575	79.6	4.8	10610	46.6	7.5	27825	1.7	4.1	4.1	1.0	0.2	5.6	5.2	0.7
HAILEYBURY	12965	5.6	3180	71.8	10.2	1740	37.3	9.2	4765	1.9	3.1	1.4	0.7	0.2	5.8	4.1	5.0
HALIFAX	222637	6.1	61515	80.3	6.2	35585	44.0	7.9	95505	1.7	4.8	3.7	1.2	0.2	4.3	10.0	1.1
HAMILTON	498523	9.0	142380	81.3	6.1	74580	41.0	10.4	212660	1.9	4.0	3.1	0.8	0.2	4.0	4.0	0.7
HAWKESBURY	10771	0.6	2530	70.7	14.4	1305	34.2	11.2	3685	1.9	3.8	1.2	0.5	0.3	4.2	3.3	4.3
JOLIETTE	29350	6.9	7005	68.3	8.7	4170	37.3	10.0	10830	1.7	3.6	1.3	1.7	0.5	6.2	8.0	0.4
KAMLOOPS	43790	32.1	12380	79.9	6.5	6400	43.9	9.8	18490	1.9	2.7	2.5	0.7	0.1	3.9	6.1	0.7
KAPUSKASING	12834	1.7	3270	74.8	9.0	1300	32.1	14.0	4420	2.6	2.5	2.0	0.6	0.1	5.5	2.7	0.7
KELOWNA	36956	43.7	9320	70.9	9.3	5260	37.9	15.7	14205	1.8	3.3	1.6	0.6	0.3	3.9	4.1	0.8
KENORA	13064	-2.4	3700	78.6	8.2	1955	40.9	9.7	5555	1.9	3.8	2.4	1.6	0.4	3.9	4.3	3.1
KENTVILLE	11571	5.6	2990	76.1	6.2	1640	39.1	7.0	4560	1.8	5.0	1.3	0.9	0.2	4.5	7.0	3.6
KINGSTON	85877	4.5	23310	76.2	6.5	14710	46.0	8.0	37345	1.6	3.6	4.0	1.5	0.2	6.8	7.7	0.8
KITCHENER	226846	18.0	67065	84.3	5.2	40185	49.1	7.3	105870	1.7	4.2	2.6	0.7	0.2	4.3	2.8	0.8
LA TUQUE	13099	-3.3	3350	72.8	11.8	1285	27.6	15.1	4430	2.8	3.5	1.8	0.8	0.6	5.5	4.7	1.2
LABRADOR CITY	11009	42.8	3295	93.3	2.6	830	26.9	12.0	4045	4.1	1.7	1.9	0.9	0.2	4.6	2.1	4.1
LACHUTE	15294	-2.0	3770	69.0	13.5	1845	32.7	11.9	5310	2.1	2.9	1.3	0.9	0.3	5.0	2.4	4.7
LEAMINGTON	10435	9.2	2650	73.3	6.0	1775	43.0	9.4	4370	1.5	2.3	0.9	0.2	0.6	3.1	4.0	0.9
LINCOLN	14247	99.9	3850	77.7	3.2	1895	36.8	7.2	5705	2.0	3.2	2.0	0.1	0.4	3.6	3.6	0.7
LINDSAY	12746	5.4	3265	75.7	5.7	2190	43.2	7.2	5405	1.5	3.1	2.1	0.7	0.2	5.2	4.9	0.9
LONDON	286011	12.7	80585	81.0	5.7	50875	47.2	7.5	129555	1.6	4.5	2.5	1.1	0.3	4.6	5.7	0.9
MAGOG	14383	-3.6	4550	71.9	9.2	1975	37.0	10.4	5365	1.8	3.6	2.2	0.7	0.2	3.4	4.1	2.1
MATANE	11841	6.6	2830	70.8	16.9	1600	36.6	12.7	4090	1.7	3.8	1.6	1.0	0.5	6.8	3.9	0.9

MEDICINE HAT	28773	3.8	7450	74.3	7.7	4190	38.7	11.7	11315	1.8	2.5	1.5	0.6	0.3	4.2	5.3	0.8
MIDLAND	23503	12.0	5945	72.4	7.1	3555	41.8	8.9	9355	1.7	3.0	2.1	3.7	0.3	3.5	5.0	3.7
MONCTON	71416	8.1	18430	76.7	6.5	10850	40.7	8.7	28670	1.7	4.1	2.2	0.8	0.5	4.4	4.2	0.7
MONTMAGNY	12432	1.6	3015	70.6	10.0	1560	33.3	7.3	4420	1.9	3.1	0.8	1.0	0.6	5.2	3.7	0.7
MONTREAL	2743208	6.7	716550	74.4	8.9	394340	38.3	9.9	1079785	1.8	6.0	3.2	1.1	0.2	3.9	3.9	1.4
MOOSE JAW	31854	-4.7	7825	69.8	7.0	4795	38.3	10.9	12320	1.6	3.9	0.8	0.9	0.5	5.0	8.2	0.7
NANAIMO	38760	19.0	10915	77.9	8.3	5110	36.7	11.8	15595	2.2	2.7	2.3	0.9	0.1	3.6	3.3	0.8
NEWCASTLE	19762	0.6	4915	75.3	9.0	2160	32.6	11.1	6895	2.3	2.8	1.8	0.6	0.3	3.6	5.1	4.4
NEW GLASGOW	23435	1.6	5990	73.4	11.4	2740	31.3	10.4	8530	2.2	3.7	0.9	3.0	0.4	3.7	3.8	0.0
NEW HAMBURG	10010	13.3	2880	85.6	3.3	1490	44.8	6.7	4315	1.9	1.9	0.9	1.2	0.5	3.0	2.3	2.7
NORTH BATTLEFORD	15148	1.1	3690	70.2	5.6	2410	42.7	7.1	5995	1.5	3.4	2.9	2.0	0.3	5.1	9.8	3.4
NORTH BAY	49187	99.9	12530	77.6	6.1	6985	41.1	9.6	19105	1.8	4.4	3.0	0.8	0.4	5.0	5.7	0.6
ORILLIA	24040	99.9	6010	69.5	6.1	3665	41.3	8.2	9485	1.6	3.6	2.1	5.2	0.3	4.1	7.5	0.7
OROMOCTO	11427	-19.0	3085	85.6	2.9	1035	32.4	17.6	4050	3.1	1.0	0.6	0.5	0.2	3.0	1.9	0.4
OSHAWA	106453	-3.9	33285	81.2	6.2	17185	40.9	10.0	49425	1.9	3.6	2.5	0.6	0.2	4.1	4.6	0.7
OTTAWA-HULL	602510	13.9	164380	79.7	5.7	101045	45.9	7.2	260235	1.6	8.3	5.9	1.8	0.2	4.7	3.5	1.6
OWEN SAUND	18469	3.9	4930	79.5	6.9	3170	43.6	7.2	7985	1.5	3.8	2.6	0.6	0.3	3.8	6.3	0.9
PEMBROKE	20299	2.8	5295	75.5	8.6	3135	41.8	9.7	8150	1.7	3.2	2.2	3.9	0.4	5.3	5.6	4.2
PENTICTON	18146	18.4	4805	72.8	10.5	2720	38.5	14.2	7355	1.8	3.4	1.7	0.6	0.3	2.7	4.4	1.3
PETAWAWA	14290	5.2	3930	84.7	4.7	1340	34.0	18.3	5100	3.2	1.6	2.6	1.3	0.5	2.9	2.1	1.9
PETERBOROUGH	61531	3.6	17460	79.3	7.7	10200	42.2	9.9	26985	1.7	4.2	4.4	1.0	0.2	4.4	4.7	0.8
PORTAGE LA PRAIR.	12950	-0.5	2930	63.7	6.6	1980	40.8	7.4	4840	1.5	3.1	1.1	1.7	0.3	6.1	11.1	1.2
PORT ALBERNI	26509	11.1	8085	85.6	5.9	2780	32.8	11.7	10650	2.9	2.2	1.3	0.6	0.2	3.0	2.2	0.6
PRINCE ALBERT	28464	8.3	7090	72.8	7.5	4190	41.7	9.7	11005	1.7	3.8	2.2	1.6	0.6	5.0	6.0	0.7
PRINCE GEORGE	49100	30.1	14140	86.3	9.2	6530	44.0	10.3	20330	2.2	3.7	2.1	0.8	0.2	4.2	2.9	0.6
PRINCE RUPERT	16766	6.9	5160	83.6	8.7	2410	46.8	11.6	7435	2.2	3.1	2.6	0.9	0.3	2.8	2.9	2.8
QUEBEC	480502	14.1	117365	71.5	7.9	66240	36.2	8.4	178115	1.8	6.0	3.1	1.6	0.4	4.8	5.8	1.1
RED DEER	27674	5.7	7070	73.9	5.8	4560	46.2	8.2	11405	1.6	3.9	1.8	1.1	0.1	4.7	10.4	0.8
REGINA	140734	6.3	38460	80.5	7.1	24575	47.7	8.4	61620	1.6	5.8	3.5	1.2	0.3	3.9	4.5	1.1
RIMOUSKI	28956	7.2	6585	69.0	10.9	4325	39.7	10.5	10400	1.5	4.4	2.4	1.6	1.1	7.3	5.6	1.0
RIVIERE-DU-LOUP	12710	9.6	2845	64.5	10.2	1735	34.3	10.2	4370	1.6	3.8	1.5	1.4	1.7	6.4	6.4	0.3
ROUYN	28562	-5.1	6630	67.9	12.4	3280	33.2	14.9	9405	2.1	4.8	2.8	0.9	0.4	6.3	3.6	0.7
SAINT JOHN	106744	2.4	27720	76.5	7.0	15610	40.1	7.8	42660	1.8	3.9	2.2	1.1	0.4	3.5	5.8	0.7
SAINT GEORGES	13554	10.9	3020	67.9	11.9	1855	37.9	9.2	4695	1.6	4.2	0.7	0.6	0.4	8.3	6.5	2.9
SAINT HYACINTHE	39693	4.2	9690	70.4	9.2	6340	39.5	8.3	15580	1.5	3.9	1.4	0.7	2.2	4.2	4.6	0.9
SAINT JEAN	47044	7.8	13225	76.2	8.4	5965	36.0	13.2	18580	2.3	4.0	1.9	1.0	0.2	4.8	2.6	0.8
SAINT JEROME	35335	6.2	8695	71.4	11.4	4305	34.3	11.4	12510	2.5	4.3	1.6	1.0	0.3	4.6	4.2	0.8
SAINT SCHOLASTIQ.	14787	99.9	3240	66.7	10.4	1190	25.9	14.4	4275	2.9	1.4	0.6	0.6	0.2	3.2	1.5	0.6
SARNIA	78444	5.6	22335	81.4	7.6	11005	39.7	10.4	32695	2.1	4.2	5.7	0.7	0.2	4.1	3.9	0.7
SASKATOON	126449	9.1	33720	78.6	8.1	20800	44.3	9.7	53275	1.6	4.2	3.2	1.2	0.3	5.6	6.4	1.2
SAULT STE.MARIE	81270	7.6	22840	80.6	7.3	10605	38.7	10.9	32635	2.2	2.9	2.9	0.6	0.2	4.5	3.7	0.7
SEPT-ILES	24320	28.3	6440	79.1	7.6	2430	33.3	10.3	8675	2.7	4.8	2.9	0.6	0.2	4.1	3.5	0.5
SHAWINIGAN	57246	-8.0	13490	66.3	17.3	5890	27.5	18.1	17975	2.3	3.3	2.3	0.8	0.2	5.9	3.7	0.8
SHERBROOK	84570	6.1	20245	70.7	9.4	12950	39.8	9.2	32160	1.6	4.6	2.2	1.5	0.5	7.1	7.6	1.2
SIMCOE	10793	8.7	2965	76.0	5.3	1855	44.2	7.5	4780	1.6	3.9	2.2	0.6	0.1	3.9	5.2	0.8
SMITHS FALLS	14044	-3.6	3295	64.2	5.8	2290	43.0	7.0	5480	1.4	2.8	2.5	0.8	0.2	4.7	10.3	6.5
SOREL	34479	2.4	8675	71.5	10.2	3730	29.8	17.6	11760	2.4	4.3	4.0	0.6	0.4	4.9	4.9	0.9
ST.CATHARINES-N.	303429	6.3	84320	79.4	6.2	43630	39.5	11.0	125400	2.0	3.5	2.8	0.6	0.2	3.9	3.4	0.6
ST.JOHN'S	131814	12.1	31640	72.9	9.0	17695	38.7	6.9	48060	1.8	5.0	2.8	0.9	0.2	4.6	7.0	0.9
STRADFORD	24508	6.2	7145	81.0	5.1	4460	46.8	7.5	11455	1.6	5.0	2.8	0.9	0.2	4.6	7.0	0.9
SUDBURY	155424	13.7	44870	82.5	4.5	18520	37.2	10.0	62150	2.5	3.2	3.4	0.6	0.1	4.2	3.0	0.4
SUMMERSIDE	14004	-4.6	3620	79.4	5.4	1855	39.7	7.8	5420	1.9	2.8	2.7	1.2	0.4	4.3	5.1	2.9
SWIFT CURRENT	15415	6.4	4085	76.3	6.0	2470	42.7	7.3	6445	1.7	4.4	2.9	1.1	0.8	4.0	6.0	0.9
SYDNEY	91162	-0.7	20445	65.2	12.9	9635	30.6	11.8	28860	2.1	2.8	1.4	0.8	0.4	4.4	4.8	0.6
SYDNEY MINES	34026	0.3	7515	68.0	12.4	2990	27.0	12.2	10070	2.6	2.5	1.1	0.3	0.4	5.1	3.6	0.3
TERRACE	13902	29.4	3910	82.1	8.4	1870	45.6	12.6	5640	2.2	3.1	1.3	1.0	0.4	3.7	4.5	3.1
THETFORD MINES	26126	1.3	6290	69.7	9.3	2855	29.6	14.7	8720	2.3	3.9	2.5	0.8	0.2	6.6	3.6	0.6
THOMPSON	19001	99.9	6740	95.0	2.7	2040	40.5	12.3	8715	3.4	3.3	5.8	0.2	0.2	2.0	2.2	0.3
THUNDER BAY	112093	3.7	31115	76.5	8.4	16485	41.2	8.2	46640	1.9	3.9	2.3	0.9	0.3	4.1	5.1	0.7
TIMMINS	41473	-1.8	10755	73.8	9.4	4915	35.1	12.6	15085	2.3	2.5	2.9	0.9	0.5	4.6	3.3	0.6

TORONTO	2628043	1.5	779745	83.0	6.2	485310	49.4	8.0	1244850	1.6	6.0	3.6	1.2	0.2	3.4	3.4	1.5
TRAIL	17177	-7.1	5090	78.4	7.8	2345	37.3	11.7	7235	2.2	2.6	2.7	0.8	0.3	3.2	5.7	7.3
TRENTON	28650	4.6	7905	80.6	4.7	4030	41.7	9.4	11750	2.0	2.6	2.5	0.4	0.0	3.1	3.1	0.4
TROIS-RIVIERES	97930	2.6	23750	69.9	12.7	12370	33.6	11.8	34535	1.9	4.1	1.7	1.1	0.6	5.7	4.3	0.8
TRURO	24914	7.0	6295	74.9	6.7	3640	40.2	7.0	9785	1.7	3.3	2.1	0.8	0.2	5.4	3.3	4.5
VAL d'OR	19165	-5.3	4560	70.2	14.9	2130	34.1	17.4	6325	2.2	2.8	3.1	1.3	0.6	4.8	3.3	4.6
VALLEYFIELD	37430	2.4	9410	72.0	11.7	4395	32.5	15.6	13020	2.2	3.2	2.4	1.1	0.3	4.4	2.3	0.8
VANCOUVER	1082352	16.0	308215	77.6	8.9	177725	43.2	10.2	474560	1.7	4.4	3.0	1.1	0.2	3.4	4.1	1.1
VERNON	13283	16.3	3375	71.1	7.8	1975	38.1	12.1	5215	1.7	3.3	1.2	1.0	0.6	4.1	4.4	0.7
VICTORIA	195800	11.7	51580	73.3	8.0	31230	39.8	8.8	80980	1.7	3.4	3.1	1.0	0.2	3.7	5.0	1.2
VICTORIAVILLE	26526	4.9	6485	71.9	9.0	3920	39.4	8.9	10025	1.7	3.6	1.0	0.7	0.2	5.3	6.0	0.9
WALLACEBURG	10550	-1.4	2910	80.5	7.2	1610	43.2	13.0	4400	1.8	3.0	1.5	0.6	0.6	2.3	3.2	0.6
WHITEHORSE	11217	37.9	3400	87.6	6.0	1885	54.5	7.6	5220	1.8	4.1	3.0	1.1	0.4	3.6	2.6	1.0
WILLIAMS LAKE	11407	27.4	3305	86.2	5.6	1480	42.0	9.8	4715	2.3	3.0	2.5	1.9	0.2	3.8	3.6	3.1
WINDSOR	258643	8.5	70475	78.3	8.3	36960	39.6	9.6	105405	1.9	4.2	2.1	0.8	0.2	4.1	3.8	0.7
WINNIPEG	540262	6.2	152060	79.4	6.9	95995	46.6	8.2	243795	1.6	5.1	2.9	1.2	0.2	4.0	4.4	1.1
WOODSTOCK	26173	8.9	7565	81.4	5.1	4370	43.9	7.6	11790	1.7	3.9	1.9	0.6	0.3	3.6	6.4	0.7
YORKTON	13430	6.2	3570	75.2	7.1	2085	41.3	6.6	5515	1.7	4.4	2.3	1.5	0.2	4.1	6.4	1.0

1971 DATA MATRIX - CONTINUED (For explanation of codes see Table 4., pp.35,36)

NAME	R22	R23	R24	R25	R26	R27	R28	R29	R30	R31	R32	R33	R34
ALMA	3.8	13.4	12.8	1.3	8.9	4.4	6.0	9.0	3.1	1.7	1.0	34.1	64.4
ARNPRIOR	2.2	8.0	7.0	6.2	8.8	14.1	9.4	8.6	3.6	5.9	6.0	56.3	43.3
ASBESTOS	8.7	5.9	8.3	13.2	3.8	17.3	6.3	6.3	5.6	3.9	5.5	48.5	38.4
BAIE-COMMEAU	3.9	7.0	10.7	2.2	11.6	3.5	7.1	8.3	3.6	3.3	1.2	38.6	48.8
BARRIE	5.8	12.4	112.9	13.9	2.6	2.2	19.9	17.7	3.9	1.5	1.1	29.8	57.1
BATHURST	3.8	11.9	11.5	6.7	6.6	1.8	5.5	7.0	3.8	2.2	1.4	28.3	56.6
BELLEVILLE	8.4	10.0	13.6	0.8	2.6	3.5	7.6	5.8	4.7	2.4	1.2	27.7	62.0
BRANDON	5.7	12.8	15.1	2.3	2.2	1.2	5.2	7.1	4.4	1.8	1.5	23.3	63.8
BRANTFORD	5.8	9.6	9.90	3.1	5.6	7.0	12.6	4.4	3.0	3.4	1.4	37.3	49.8
BROCKVILLE	4.1	11.0	12.0	0.9	3.8	3.2	10.6	5.3	2.7	1.7	1.1	28.5	61.3
CALGARY	9.7	11.5	12.9	1.8	1.8	2.0	4.9	8.4	3.7	1.9	1.1	23.8	65.1
CAMPBELLTON	3.9	10.0	12.4	1.8	4.0	7.1	14.9	7.6	4.9	3.4	3.4	35.3	62.9
CHARLOTTETOWN	5.1	3.8	15.5	2.0	2.4	1.1	2.7	7.0	4.2	1.4	1.2	20.1	63.0
CHATHAM	5.3	12.6	12.0	1.9	3.6	5.6	0.6	5.9	3.3	2.6	0.9	30.6	57.8
CHICOUTIMI-JONQ.	12.5	9.2	12.1	2.0	6.5	4.1	5.8	6.0	3.3	2.1	1.0	28.8	53.5
CHILLIWACK	11.1	10.3	20.7	12.5	5.0	1.2	4.4	7.6	3.8	2.2	0.8	25.0	53.2
COBOURG	13.1	9.5	12.6	5.8	5.4	11.8	0.8	5.9	2.8	0.1	9.1	35.9	58.3
CORNER BROOK	15.1	12.1	10.8	0.8	9.0	1.3	6.2	7.6	5.8	4.7	2.0	36.7	54.3
CORNWALL	14.4	9.0	11.5	1.3	10.9	2.1	9.5	5.8	3.3	2.3	1.4	35.2	52.0
COURTENAY	11.2	10.5	31.8	7.2	1.9	6.4	1.0	5.4	3.0	0.7	3.3	21.6	71.2
COWANSVILLE	14.1	9.1	8.1	1.2	13.3	2.9	13.7	5.0	1.9	2.3	2.6	41.8	45.6
CRANBROOK	16.2	11.5	12.8	3.9	4.7	1.7	6.4	10.4	9.2	2.9	1.0	36.4	53.5
DAWSON CREEK	15.9	10.0	13.0	5.0	2.4	1.3	6.1	9.6	6.0	3.1	1.4	29.8	53.5
DOLBEAU	10.0	10.5	10.3	7.4	9.2	7.3	6.3	5.5	2.7	5.7	5.4	42.2	49.1
DRUMMONDVILLE	12.3	9.2	10.6	2.0	10.3	3.5	13.7	5.0	2.8	1.7	2.6	39.6	47.8
EDMONTON	18.8	10.7	12.4	2.8	2.6	2.1	5.4	8.0	4.0	2.1	1.0	25.3	61.7
EDMUNDSTON	13.5	11.6	14.4	2.8	7.0	0.7	7.4	7.7	5.3	1.4	1.5	30.9	60.2
FLIN FLON	10.7	8.6	12.2	11.2	9.3	8.7	2.8	6.4	3.8	1.9	6.9	39.8	48.6
FREDERICTON	20.0	11.4	14.3	1.9	2.0	0.8	4.4	6.2	2.7	1.6	1.6	19.3	70.4
GASPE	8.7	6.7	13.2	10.0	7.6	1.2	3.8	7.9	6.6	1.6	0.7	29.5	47.3
GRANBY	14.2	9.9	10.0	1.9	10.2	3.5	14.2	4.8	2.5	1.2	2.0	38.5	47.4
GRAND FALLS	13.5	11.3	10.6	1.6	12.4	6.8	2.8	8.7	3.8	1.5	5.3	41.3	55.6
GRANDE PRAIRIE	14.5	12.9	13.5	3.3	3.1	2.0	5.5	8.7	4.1	3.8	0.5	27.8	58.5
GUELPH	15.3	9.5	11.4	2.2	5.0	5.2	9.5	5.2	2.7	1.9	0.9	30.3	57.1
HAILEYBURY	15.3	10.9	10.1	6.1	3.4	7.1	4.4	9.4	4.3	1.9	5.9	36.4	56.7
HALIFAX	19.6	10.1	20.5	0.8	1.4	1.3	4.4	5.8	3.6	2.3	1.3	20.1	75.5
HAMILTON	16.2	10.1	9.8	2.1	5.8	5.5	8.7	6.3	3.7	3.8	1.2	34.9	52.9
HAWKESBURY	10.3	10.3	9.2	1.6	12.1	14.7	5.2	5.7	2.6	3.0	6.1	49.3	47.8
JOLIETTE	12.4	11.4	12.0	1.6	6.6	1.0	8.9	5.4	3.6	1.6	1.6	28.7	57.8
KAMLOOPS	13.2	12.3	13.5	3.4	3.5	1.5	5.5	11.5	5.4	3.0	1.1	31.5	55.7
KAPUSKASING	11.5	7.7	12.2	5.5	14.3	1.7	6.4	7.9	4.2	2.7	1.9	39.1	45.6
KELOWNA	15.2	12.8	11.9	5.5	3.7	1.2	6.0	11.8	3.4	2.9	0.9	30.0	54.5
KENORA	13.1	10.3	14.4	2.9	6.9	4.9	3.8	8.7	7.7	1.7	5.9	39.5	57.2
KENTVILLE	14.3	14.5	12.7	6.3	3.8	5.0	2.6	7.6	4.8	1.8	3.7	29.4	64.0
KINGSTON	15.4	8.9	18.2	1.8	3.8	1.8	3.9	6.3	2.4	1.2	1.0	20.3	67.2
KITCHENER	16.2	9.8	9.3	1.5	6.2	6.8	13.1	5.6	2.7	3.1	1.0	38.4	50.9
LA TUQUE	13.4	7.3	9.9	2.9	14.8	2.5	6.8	6.3	4.0	1.7	2.1	38.1	48.9
LABRADOR CITY	10.4	4.0	7.7	12.9	5.1	15.3	2.3	9.5	6.4	2.6	6.2	47.5	37.5
LACHUTE	12.5	9.2	10.3	2.2	11.5	15.4	2.0	5.3	3.6	1.8	5.4	44.9	49.6
LEAMINGTON	11.8	10.3	10.5	6.8	12.6	2.3	7.4	6.2	3.0	4.5	1.0	37.0	44.6
LINCOLN	9.9	9.0	7.7	21.4	2.7	5.9	7.0	7.9	3.7	1.7	0.5	29.4	40.2
LINDSAY	13.8	11.1	14.2	1.2	5.2	3.6	10.5	5.5	2.6	2.1	2.0	31.5	56.2
LONDON	18.1	11.0	11.7	3.2	2.1	3.3	8.3	5.8	3.5	2.6	1.3	26.9	60.6
MAGOG	11.5	8.8	9.6	0.7	19.4	14.3	1.6	4.8	2.8	2.1	7.1	52.0	46.1

MATANE	14.2	10.8	13.2	4.5	3.4	1.7	7.1	7.6	4.5	1.5	0.7	26.5	56.6
MEDICINE HAT	12.7	11.1	14.1	5.9	5.8	1.8	5.4	6.6	5.8	3.5	1.3	30.2	53.2
MIDLAND	10.4	8.9	9.9	2.8	3.3	22.3	0.9	5.9	5.2	0.7	6.9	45.3	50.5
MONCTON	21.6	13.8	12.2	1.0	2.3	1.9	15.6	6.2	5.7	3.2	1.3	26.2	64.4
MONTMAGNY	13.3	8.9	11.7	4.9	4.9	3.7	9.5	6.6	3.3	0.8	2.0	30.8	49.0
MONTREAL	19.8	10.0	10.0	0.7	3.2	2.7	9.8	4.7	3.8	2.0	1.5	27.6	59.5
MOOSE JAW	12.1	11.2	19.7	4.0	1.7	1.3	6.6	5.9	5.3	1.5	1.2	23.5	62.9
NANAIMO	13.9	11.7	13.6	6.1	5.1	2.3	5.5	8.8	4.8	3.8	1.4	31.6	52.9
NEWCASTLE	10.2	11.1	24.4	2.9	4.6	4.8	3.0	8.0	3.6	2.6	5.7	32.3	64.3
NEW GLASGOW	14.6	12.8	12.2	3.6	3.2	14.0	1.3	9.0	3.8	1.1	5.8	38.0	55.1
NEW HAMBURG	12.7	7.6	7.6	14.5	6.1	16.1	1.6	7.3	4.5	0.7	7.9	44.3	40.4
NORTH BATTLEFORD	13.4	11.7	16.8	4.8	1.3	4.8	1.6	6.8	3.8	0.9	5.8	24.2	69.0
NORTH BAY	16.9	11.0	17.1	1.4	1.6	2.2	4.9	7.3	4.7	1.3	1.5	23.4	64.9
ORILLIA	14.4	11.3	13.3	1.3	4.2	6.0	4.8	5.2	3.0	1.6	1.0	25.8	62.6
OROMOCTO	8.6	4.7	69.5	0.9	0.0	0.0	0.6	1.5	0.7	0.7	0.2	3.8	90.4
OSHAWA	17.3	9.9	9.7	1.8	3.2	5.9	15.0	5.4	3.2	2.7	1.3	36.7	53.0
OTTAWA-HULL	24.7	8.3	12.7	1.3	1.8	0.9	3.7	5.5	2.7	1.0	1.7	17.3	71.6
OWEN SAUND	16.0	11.2	12.3	1.5	3.0	4.0	9.5	4.4	3.5	2.4	3.2	30.0	57.7
PEMBROKE	14.9	8.5	17.2	3.1	3.0	8.2	1.6	7.1	3.4	1.0	6.0	30.2	65.6
PENTICTON	15.2	12.8	15.8	5.4	3.2	1.8	5.6	10.1	3.9	2.6	0.8	27.9	58.3
PETAWAWA	10.1	4.8	50.7	1.4	1.0	3.2	2.0	3.3	2.4	1.6	3.6	17.1	78.4
PETERBOROUGH	17.1	11.3	12.3	1.5	2.4	5.2	10.0	5.8	2.8	2.3	1.0	29.4	60.5
PORTAGE LA PRAIR.	12.7	9.6	20.7	5.0	3.2	0.3	5.6	6.3	2.1	1.4	1.3	20.2	67.6
PORT ALBERNI	9.6	6.7	10.7	10.0	14.9	2.7	7.8	5.6	3.8	8.4	0.9	44.1	36.9
PRINCE ALBERT	15.8	11.2	15.4	3.2	4.5	1.3	4.6	6.5	3.6	1.8	1.1	23.4	62.3
PRINCE GEORGE	15.4	10.5	11.9	4.1	5.6	1.8	6.6	9.8	5.4	4.5	1.2	34.8	52.1
PRINCE RUPERT	13.0	8.1	12.3	7.4	12.0	8.3	4.0	6.7	6.3	1.3	7.6	46.2	48.6
QUEBEC	19.5	10.1	12.5	0.9	2.2	1.7	5.8	6.0	3.3	1.1	1.3	21.3	65.0
RED DEER	14.7	13.2	14.9	3.5	1.9	1.3	5.0	6.9	4.1	1.8	1.0	21.9	65.7
REGINA	22.2	11.8	14.3	2.2	1.8	1.5	4.3	5.8	4.1	2.0	1.4	20.9	68.5
RIMOUSKI	18.2	11.4	12.7	1.5	1.7	0.8	4.1	7.8	3.7	0.7	1.2	20.1	65.6
RIVIERE-DU-LOUP	14.3	12.5	14.0	1.7	2.7	1.3	5.8	7.2	4.7	0.9	1.1	23.8	62.2
ROUYN	15.5	10.8	10.7	12.6	2.4	2.2	4.9	6.8	3.9	1.6	0.6	22.5	56.6
SAINT JOHN	18.4	11.1	12.1	1.5	3.4	2.6	5.5	7.7	4.7	4.5	1.7	30.2	59.2
SAINT GEORGES	11.4	10.9	12.2	3.3	5.6	11.6	2.3	7.1	3.1	2.1	3.4	35.4	58.1
SAINT HYACINTHE	12.9	10.6	9.9	1.8	6.8	2.4	13.1	5.3	2.8	1.6	1.0	33.1	51.3
SAINT JEAN	13.5	8.6	17.8	0.9	7.1	2.9	11.8	5.1	3.1	1.4	2.0	33.4	55.2
SAINT JEROME	12.8	10.4	10.8	1.2	7.2	2.8	12.1	7.0	3.8	1.4	1.1	35.4	50.9
SAINT SCHOLASTIQ.	8.0	7.3	17.7	16.1	4.0	13.4	11.2	11.5	4.0	2.0	0.6	36.6	31.0
SARNIA	14.1	10.0	12.0	3.0	5.7	3.3	6.0	8.5	3.9	2.8	2.0	32.1	55.7
SASKATOON	17.4	12.5	13.6	3.1	2.6	1.2	4.8	6.4	4.1	2.3	1.4	22.8	65.6
SAULT STE.MARIE	14.5	8.5	11.2	1.9	8.7	4.7	6.6	8.2	4.2	4.5	1.4	38.3	49.8
SEPT-ILES	15.0	8.2	10.9	5.1	1.0	3.1	9.5	9.7	6.9	2.8	0.7	33.6	50.7
SHAWINIGAN	12.3	9.3	9.8	2.0	12.8	3.4	9.8	5.5	3.5	1.4	1.6	38.0	48.1
SHERBROOK	15.4	10.0	11.3	0.9	5.3	2.9	7.0	5.0	3.0	1.2	1.1	25.4	61.3
SIMCOE	15.7	14.6	11.5	3.9	4.3	5.0	5.5	6.0	3.1	3.2	2.4	29.6	58.6
SMITHS FALLS	12.7	10.3	12.6	2.2	2.6	10.3	5.8	5.1	6.7	5.7	5.9	42.2	63.3
SOREL	13.0	8.4	9.6	0.6	6.5	8.4	10.5	7.1	3.0	2.3	1.1	39.0	50.9
ST.CATHARINES-N.	14.1	9.4	12.2	3.1	6.3	7.0	8.8	6.0	3.6	2.5	1.1	35.4	50.8
ST.JOHN'S	18.5	10.9	12.9	1.9	1.8	1.3	4.3	7.1	4.9	2.3	1.6	23.4	63.8
STRADFORD	18.5	10.9	12.9	1.9	1.8	1.3	4.3	7.1	4.9	2.3	1.6	23.4	63.8
SUDBURY	16.7	7.8	9.5	14.4	4.6	2.2	5.8	8.2	4.3	2.4	1.0	28.7	44.9
SUMMERSIDE	11.2	10.0	29.7	3.7	4.2	5.7	5.4	6.1	3.5	2.2	4.2	31.5	70.1
SWIFT CURRENT	13.8	13.7	16.5	5.7	1.9	1.8	5.0	6.9	3.6	2.4	1.2	22.8	64.0
SYDNEY	11.1	10.1	13.1	8.1	4.3	2.3	7.0	8.3	5.2	3.2	1.4	32.8	49.4
SYDNEY MINES	10.5	9.7	11.5	7.8	6.8	2.0	4.7	8.3	8.1	5.1	1.0	36.0	45.1
TERRACE	13.1	9.1	10.0	11.7	6.1	6.3	5.6	8.2	6.4	2.4	6.7	41.7	49.5
THETFORD MINES	11.8	10.8	10.1	12.4	4.0	3.2	8.3	5.0	3.9	1.3	0.7	26.4	50.9
THOMPSON	10.6	6.1	8.4	19.5	4.8	2.0	5.7	8.7	5.2	3.0	0.6	29.9	39.1
THUNDER BAY	14.8	9.8	12.8	3.5	5.0	2.5	6.3	7.6	5.4	3.8	1.3	31.9	54.7

TIMMINS	13.5	9.3	11.3	13.3	3.5	1.9	5.4	8.7	4.8	2.4	1.2	27.9	49.4
TORONTO	22.3	10.4	9.5	1.1	2.5	3.5	8.6	5.7	3.3	2.6	1.7	28.0	61.3
TRAIL	12.6	8.3	11.7	2.9	11.5	7.7	4.5	8.8	3.5	2.3	9.0	47.3	55.1
TRENTON	12.3	7.0	23.7	3.4	4.0	3.7	12.0	3.9	3.3	1.9	1.4	30.2	55.1
TROIS-RIVIERES	13.8	10.2	11.1	1.0	7.6	3.1	9.3	5.9	3.8	2.2	1.6	33.5	53.3
TRURO	13.4	13.5	12.9	4.7	4.8	8.6	10.0	8.0	5.6	1.2	5.1	43.3	59.6
VAL d'OR	12.5	10.8	15.7	13.1	2.6	6.7	4.7	5.7	4.0	2.4	3.2	29.3	59.6
VALLEYFIELD	12.6	9.4	9.4	1.4	12.5	2.8	10.3	7.1	3.6	1.9	1.3	39.5	46.0
VANCOUVER	18.7	11.8	12.4	2.8	3.9	2.5	6.1	6.8	4.0	3.3	1.2	27.8	60.2
VERNON	14.3	14.7	14.2	5.4	4.6	1.4	6.2	9.8	3.2	3.5	1.3	30.1	58.3
VICTORIA	17.2	11.3	19.5	3.4	2.4	1.6	4.5	6.6	3.4	1.9	1.1	21.5	65.6
VICTORIAVILLE	14.1	12.1	10.8	1.0	2.5	3.8	17.3	5.2	3.0	1.1	1.0	34.0	54.8
WALLACEBURG	12.7	9.4	8.3	1.1	18.6	9.3	7.7	4.3	2.0	3.4	0.9	46.4	42.0
WHITEHORSE	17.0	7.5	13.5	2.5	1.1	1.0	7.7	8.3	7.5	2.1	1.5	29.1	53.7
WILLIAMS LAKE	12.7	9.2	9.7	8.3	7.7	7.0	5.9	9.0	6.3	2.4	7.2	45.6	49.7
WINDSOR	15.7	9.6	11.8	1.7	2.7	7.2	12.9	5.1	3.7	2.7	1.0	35.3	53.1
WINNIPEG	20.6	10.7	12.6	1.2	2.4	2.6	8.4	6.0	3.9	2.3	1.4	27.1	62.8
WOODSTOCK	15.6	10.2	11.4	1.9	7.9	6.5	10.1	4.8	3.3	2.5	1.2	36.3	54.5
YORKTON	15.3	14.4	14.4	4.3	1.8	1.7	4.4	6.8	3.6	2.4	1.1	21.8	64.0

1981 DATA MATRIX (For explanation of codes see Table 4., pp.35,36)

Name	POP1	CH2	M3	M4	M5	M6	M7	F8	F9	F10	F11	F12	ALL13	R14	R15	R16	R17	R18	R19	R20	R21
ABBOTSFORD	12745	34.1	3805	79.8	4.3	5.3	4.0	2430	49.5	7.4	8.0	6.8	6170	1.6	10.1	1.8	1.2	0.2	3.5	5.8	0.5
ALMA	26322	2.6	7300	74.1	14.7	31.2	9.3	4240	42.5	21.7	33.4	15.0	10935	1.8	7.9	2.2	2.1	0.0	7.5	5.2	2.0
ASBESTOS	14229	-4.3	3895	72.3	12.2	34.4	6.2	2060	37.6	18.0	30.5	12.5	5785	1.9	4.7	2.4	0.9	0.6	3.8	4.3	0.9
BAIE-COMMEAU	29490	2.0	9010	81.0	11.7	24.9	7.9	5370	49.7	19.6	32.1	13.1	14380	1.6	4.4	5.6	7.1	0.3	5.2	3.9	1.3
BARRIE	61271	12.4	17600	77.5	5.0	11.2	3.2	12685	53.0	9.4	12.3	8.3	29940	1.3	8.7	2.5	1.6	0.1	4.6	3.6	1.3
BATHURST	24267	2.7	6325	73.6	8.6	18.4	5.7	4220	46.7	14.9	22.0	11.3	10275	1.5	7.3	3.1	1.3	0.3	5.1	5.0	0.5
BELLEVILLE	46370	0.0	13215	76.5	6.2	13.5	4.0	9830	51.5	9.3	14.4	7.2	22720	1.3	7.8	2.8	1.9	0.4	4.7	5.1	1.1
BRANDON	36242	3.8	10080	78.5	4.6	8.1	3.2	7970	54.8	6.6	7.2	6.2	17955	1.3	7.3	1.9	2.2	0.3	4.3	9.3	1.2
BRANTFORD	88330	6.6	25180	78.1	6.3	14.3	4.1	18390	52.8	7.8	12.1	6.2	43180	1.3	7.3	2.1	1.4	0.2	3.9	4.3	1.1
BROCKVILLE	35659	2.3	10305	78.6	6.0	14.7	3.3	7575	54.1	12.3	23.4	8.3	17475	1.3	7.3	4.8	1.8	0.2	3.9	6.4	1.1
CALGARY	592743	25.7	204515	87.3	2.9	5.4	2.0	143890	63.7	3.6	4.7	3.1	348405	1.4	11.6	7.5	1.8	0.2	3.2	3.5	1.4
CAMPBELL RIVER	15832	29.4	5075	83.8	6.7	12.0	5.3	3005	51.9	11.1	13.0	10.0	8010	1.7	6.3	2.0	0.9	0.0	3.7	3.1	1.1
CAMPBELLTON	15508	-1.2	3815	68.1	15.1	32.3	9.2	2805	46.7	14.1	24.1	10.2	6390	1.4	6.6	1.3	3.2	0.8	4.8	10.9	0.9
CAMROSE	12570	24.4	3425	76.8	3.9	6.6	2.9	2580	53.4	4.7	4.2	4.8	5975	1.3	7.1	1.2	1.6	0.4	4.1	7.9	1.6
CARBONEAR	12983	4.2	3220	70.5	29.2	50.3	22.9	2120	45.5	32.8	36.8	31.1	5140	1.5	6.5	1.6	0.6	0.3	4.6	3.5	0.6
CHARLOTTETOWN	44999	8.4	12305	78.3	9.1	17.3	6.6	9525	54.0	10.6	14.4	9.0	21535	1.3	10.7	3.2	2.1	0.6	4.1	7.1	1.7
CHATHAM	47182	4.3	12755	77.0	8.3	13.8	6.6	9515	52.5	11.8	15.1	10.5	21970	1.4	7.1	2.5	2.6	0.3	4.6	5.2	0.6
CHICOUTIMI-JONQ.	135172	5.0	37355	74.3	13.5	33.6	7.5	20325	39.3	20.0	34.4	12.5	54255	1.9	8.0	3.9	1.3	0.6	7.1	5.3	1.6
CHILLIWACK	41471	10.5	11400	73.2	5.4	9.9	3.8	7500	45.8	8.9	14.2	6.8	18765	1.5	6.3	1.4	1.1	0.4	3.9	4.5	0.9
COBOURG	20194	-0.3	5815	78.3	5.0	12.3	2.8	4165	52.2	9.8	14.0	8.6	9880	1.4	7.0	3.4	2.4	0.5	2.5	3.9	0.5
COLLINGWOOD	12064	8.5	3420	79.3	6.1	10.4	4.7	2545	53.2	11.4	16.6	9.1	5920	1.4	7.4	2.0	1.0	0.2	2.1	5.0	0.8
CORNER BROOK	32269	-0.1	8670	75.0	14.1	26.2	10.3	5365	45.3	17.8	24.5	14.3	13625	1.7	7.9	2.2	1.0	0.1	5.5	5.3	1.1
CORNWALL	53405	0.8	14610	73.7	8.4	17.4	5.4	10225	47.9	11.8	17.3	9.3	24310	1.4	6.1	2.4	1.5	0.3	4.4	5.1	1.0
COWANSVILLE	12240	2.8	3385	78.1	6.6	12.0	4.8	2180	49.0	11.7	16.9	8.7	5465	1.6	7.4	1.4	0.6	0.1	6.1	4.8	0.8
COURTENAY.	35218	19.8	10335	75.9	8.2	14.1	6.6	6330	47.3	12.1	17.8	10.0	16455	1.6	5.4	2.1	1.1	0.2	4.2	3.8	1.5
CRANBROOK	15915	14.9	4720	82.7	5.9	9.5	4.9	3440	58.0	10.3	12.9	9.1	8085	1.4	7.3	3.0	1.2	0.5	4.3	2.8	0.7
DAWSON CREEK	11373	8.0	3310	80.3	10.9	11.6	10.5	2480	57.5	7.7	8.9	6.6	5760	1.3	8.9	1.7	1.3	0.2	4.2	4.0	0.7
DOLBEAU	15448	10.9	4230	74.4	18.4	32.0	13.9	2160	38.9	23.6	33.1	17.2	6140	2.0	6.5	1.6	1.4	1.0	5.5	4.7	1.1
DRUMMONDVILLE	54679	3.9	15345	75.1	10.8	19.7	8.1	10175	47.0	15.5	25.3	11.4	24590	1.5	6.7	2.0	1.4	0.4	5.0	3.9	1.5
EDMONTON	657057	17.5	254490	85.6	3.7	6.6	2.5	155685	62.4	4.1	5.6	3.4	371895	1.6	10.3	4.8	1.7	0.2	3.9	4.5	1.3
EDMUNDSTON	21901	4.5	5625	71.4	11.6	20.7	8.9	3840	45.0	14.6	23.2	10.7	9265	1.5	7.1	2.3	1.6	0.3	3.9	6.0	1.2
FERGUS	12125	3.3	3520	80.3	3.3	9.3	1.6	2475	54.2	4.6	7.8	3.5	5955	1.4	7.6	2.5	1.2	0.4	5.0	5.3	1.4
FLIN FLON	9897	-3.9	3005	78.4	3.0	6.2	1.8	1765	49.0	8.2	14.3	5.0	4725	1.7	4.9	3.8	1.6	0.4	3.6	4.8	0.7
FORT McMURRAY	31000	5.0	10570	92.4	3.0	7.6	1.2	6170	62.6	6.6	8.9	5.5	16640	1.7	7.9	5.6	1.0	0.2	4.0	2.5	0.8
FORT ST.JOHN	13891	5.0	4645	88.3	8.1	11.7	6.2	2935	61.7	8.9	10.5	8.1	7550	1.6	7.6	2.8	1.4	0.1	3.5	2.5	1.2
FREDERICTON	64439	4.8	18670	79.2	7.6	16.8	5.0	13740	53.9	8.6	12.9	6.9	31885	1.3	10.2	5.3	2.5	0.4	5.8	4.0	1.7
GRANBY	45667	6.6	13560	77.9	7.3	11.4	5.8	9215	51.0	14.1	18.8	11.8	22285	1.5	7.4	2.3	1.0	0.4	4.2	3.3	1.0
GRAND FALLS	14512	-3.7	3660	72.5	13.1	32.1	7.8	2300	43.0	15.4	17.2	14.6	5795	1.6	7.0	2.1	1.2	0.9	7.1	6.6	1.0
GRANDE PRAIRIE	24263	3.7	8125	88.3	3.4	4.1	2.9	5360	63.4	4.9	5.8	4.0	13465	1.5	9.3	4.2	1.6	0.1	3.1	2.7	1.1
GUELPH	78456	5.2	23670	81.1	4.4	8.8	3.0	17995	57.8	7.9	10.0	7.1	41250	1.3	8.2	4.0	1.4	0.3	6.8	4.7	1.3
HAYLEIBURY	13220	-3.7	3490	73.6	5.6	12.1	3.9	2235	44.0	11.6	20.6	8.1	5640	1.6	7.5	2.7	0.9	0.5	6.4	4.2	1.1
HALIFAX	277727	4.4	82685	80.0	6.3	12.6	4.3	61300	55.5	8.6	12.0	7.1	142110	1.3	9.6	4.0	1.9	0.2	4.8	6.3	1.6
HAMILTON	542095	2.4	164745	80.0	4.6	10.5	3.0	114000	52.6	7.1	11.2	5.5	275475	1.4	8.3	3.6	1.3	0.2	4.2	4.5	1.1
HAWKESBURY	11294	-0.1	3300	76.9	7.9	13.5	5.7	2045	45.5	9.0	14.9	6.3	5130	1.6	4.0	3.0	1.6	0.0	3.6	5.4	0.9
JOLIETTE	34463	3.6	9600	76.6	7.4	17.7	4.4	6915	49.0	11.6	19.1	8.3	16010	1.4	7.4	1.3	1.6	1.0	5.1	8.7	1.4
KAMLOOPS	64997	9.8	19730	82.6	4.8	9.4	3.3	13520	55.6	9.5	12.1	8.5	32880	1.4	8.0	2.8	1.6	0.2	3.7	5.6	0.9
KAPUSKASING	12014	-5.2	3545	76.9	5.5	15.4	1.9	2210	50.2	7.2	9.0	6.3	5720	1.6	5.2	3.3	1.6	0.0	4.7	5.1	0.5
KELOWNA	77468	18.8	21020	71.0	4.9	8.3	3.9	14680	46.6	10.5	13.5	9.2	35310	1.4	8.8	2.0	1.3	0.3	3.7	4.0	1.3
KENORA	15537	-3.6	4695	79.1	4.7	10.7	2.5	3170	53.1	4.4	5.9	3.9	7805	1.5	8.4	2.2	3.5	0.3	4.2	5.1	0.7
KENTVILLE	20920	8.7	5625	74.1	8.4	19.7	5.0	3875	47.4	12.6	16.8	11.0	9385	1.5	8.6	1.9	1.0	0.1	3.7	5.5	1.3
KINGSTON	114982	0.8	33930	79.4	5.9	11.3	4.3	24835	55.0	8.4	13.7	6.3	57875	1.4	6.2	3.8	2.1	0.5	6.6	7.2	1.3
KITCHENER	287801	5.7	87805	82.7	4.1	8.6	2.7	65810	59.0	7.0	9.5	5.9	152350	1.3	8.1	3.5	1.4	0.2	4.4	3.3	1.1
LA TUQUE	13589	-0.5	3900	72.3	11.0	24.7	7.2	2095	39.3	19.3	36.1	10.9	5755	1.9	5.5	2.2	1.6	0.0	3.9	6.9	0.9
LABRADOR CITY	14693	-6.9	4435	89.5	1.9	5.3	1.0	2180	48.9	18.6	26.8	14.3	6485	2.1	6.1	2.9	0.4	0.1	6.9	2.2	0.9

LACHUTE	18135	-1.7	4755	69.0	11.8	26.9	7.7	3075	41.7	15.9	25.3	12.3	7485	1.6	5.8	2.4	1.3	0.3	4.7	5.2	0.9
LEAMINGTON	21369	5.7	6030	78.0	8.0	14.0	6.1	4390	53.5	10.9	14.2	9.6	10310	1.4	6.4	1.3	0.9	0.2	2.4	3.9	1.0
LEDUC	12471	5.0	3785	87.7	2.5	4.5	2.1	2420	58.5	3.3	7.4	2.0	6190	1.6	12.8	4.1	0.5	0.2	2.6	3.5	0.6
LETHBRIDGE	54072	14.3	16030	79.9	3.7	7.2	2.5	11970	55.6	5.9	9.5	4.2	27825	1.3	8.9	2.9	1.9	0.4	4.3	4.9	1.4
LINDSAY	16836	5.7	4595	74.4	5.1	11.8	3.0	3590	51.3	11.6	16.1	9.5	8120	1.3	6.0	2.0	2.3	0.1	4.2	4.9	1.5
LONDON	283668	4.9	84935	81.0	5.7	11.5	4.0	67550	58.3	7.1	10.2	5.8	15840	1.2	8.9	2.9	1.9	0.2	4.9	6.4	1.4
LUNENBURG	24593	9.3	7165	73.6	5.8	8.3	5.2	3380	36.1	9.6	14.7	7.4	10455	2.1	3.8	2.1	0.6	0.4	2.7	3.3	0.7
MAGOG	18149	7.3	4990	73.1	8.0	19.4	4.3	3395	47.6	13.2	25.8	8.8	8165	1.5	6.4	1.6	0.6	0.4	3.2	5.8	1.1
MATANE	13612	6.9	3690	72.4	21.4	37.9	16.5	2620	46.7	20.0	23.3	18.0	5895	1.4	8.1	1.9	1.9	0.1	6.4	6.0	1.5
MEDICINE HAT	49645	19.8	15040	81.2	4.2	9.4	2.2	9470	50.6	5.9	7.4	5.1	24445	1.6	7.7	2.2	1.0	0.3	3.7	3.4	1.1
MIDLAND	33925	3.0	9375	73.8	5.5	11.4	3.5	6585	50.2	8.1	11.0	7.0	15745	1.4	5.3	1.9	1.8	0.2	4.0	6.2	1.3
MONCTON	98354	2.8	26550	74.4	8.8	17.4	6.3	18555	47.5	11.9	19.0	8.8	44330	1.4	9.8	2.4	1.7	0.3	4.1	4.5	1.5
MONTREAL	2828345	0.9	834720	77.8	7.5	15.9	5.2	593990	51.0	10.4	15.5	8.5	1398030	1.4	10.5	3.6	1.6	0.3	4.4	4.9	2.1
MOOSE JAW	36057	3.5	10020	76.3	4.6	7.9	3.5	7055	49.9	7.9	12.1	6.1	16960	1.4	7.3	1.1	1.9	0.2	4.9	7.1	0.8
NANAIMO	57694	18.5	17085	77.0	7.3	13.6	5.5	11360	50.1	11.4	14.7	10.1	28120	1.5	6.8	2.7	1.6	0.2	3.6	4.6	0.9
NEW GLASGOW	39412	1.9	10605	74.3	7.2	16.3	4.3	6055	40.8	11.9	18.4	9.1	16405	1.9	6.4	2.7	1.2	0.3	3.9	4.4	0.9
NORTH BATTLEFORD	18702	10.0	3810	75.6	3.4	7.5	1.7	2890	51.8	4.3	4.5	4.2	6680	1.3	9.1	2.0	2.3	0.3	4.3	9.6	1.1
NORTH BAY	57137	0.1	16080	76.8	6.5	14.5	4.0	11465	51.4	10.5	16.7	7.7	27115	1.4	7.9	3.5	1.3	0.3	5.2	5.3	1.1
ORANGEVILLE	13740	12.8	4050	83.9	4.0	9.8	2.2	2820	56.9	8.0	10.7	6.8	6795	1.5	8.8	2.6	0.9	0.1	4.3	3.7	0.8
ORILLIA	30860	0.1	8280	74.7	5.3	9.9	3.8	5955	49.3	7.6	11.4	6.0	14040	1.4	7.1	1.8	5.8	0.3	4.2	5.0	0.8
OROMOCTO	13648	-5.1	4475	83.7	3.9	4.8	3.2	2440	52.2	17.8	27.0	13.8	6755	1.9	3.8	1.2	0.6	0.1	2.4	2.3	1.2
OSHAWA	154217	14.1	46745	82.5	3.9	9.9	2.2	31900	54.4	10.3	15.9	8.0	77515	1.5	7.2	3.2	1.4	0.2	3.9	4.4	1.1
OTTAWA-HULL	717978	3.5	216080	80.2	6.5	14.4	4.3	170090	58.3	7.1	11.2	5.6	380230	1.2	12.3	6.2	2.9	0.3	4.6	4.5	2.5
OWEN SOUND	27295	1.7	7690	76.7	6.3	12.9	4.4	5650	52.2	8.3	13.6	6.3	13215	1.4	7.6	3.1	1.5	0.3	4.0	6.0	1.0
PEMBROKE	22187	-1.4	6245	75.3	7.0	15.8	4.2	4460	50.0	9.6	19.5	6.0	10500	1.4	6.0	2.2	1.2	0.8	5.0	5.2	0.8
PENTICTON	23181	8.2	6135	69.1	6.8	11.3	5.4	4585	46.7	10.8	15.6	9.0	10600	1.3	9.0	2.0	1.4	0.2	3.2	5.1	0.8
PETAWAWA	13240	-7.5	4815	86.7	2.4	3.2	2.0	1900	45.1	16.3	25.2	12.8	6625	2.6	3.3	2.3	0.6	0.1	3.2	2.9	0.8
PETERBORUGH	85701	1.8	24505	76.8	5.1	11.0	3.5	17740	50.9	8.8	13.5	6.9	41685	1.4	7.2	4.1	1.5	0.2	4.7	5.1	1.2
PORT ALBERNI	32558	1.2	10365	83.3	8.2	16.7	5.4	5670	48.7	14.5	21.8	11.1	15740	1.9	5.0	1.7	0.9	0.1	3.5	3.1	0.8
PORTAGE LA PRAIR.	20709	2.9	5855	80.4	5.5	9.5	3.9	4090	53.8	8.6	11.2	7.2	9865	1.4	7.7	1.3	2.8	0.3	3.5	9.1	0.8
POWELL RIVER	19364	-1.4	5860	77.7	6.9	13.6	5.1	3135	43.6	11.8	16.8	10.0	8850	1.9	4.9	1.7	1.0	0.2	3.8	4.6	1.0
PRINCE ALBERT	38331	8.7	10275	77.9	6.3	12.3	4.2	7550	53.8	8.6	13.4	6.3	17595	1.4	8.9	2.6	2.5	0.4	4.5	5.2	1.2
PRINCE GEORGE	67559	12.7	21510	87.2	7.0	11.4	5.5	14085	59.3	10.3	12.7	9.0	33120	1.5	7.5	2.9	1.3	0.2	4.3	3.8	0.8
PRINCE RUPERT	18402	7.2	5770	81.8	6.5	11.3	5.0	3905	61.7	11.5	14.8	9.9	9580	1.5	6.5	1.3	1.2	0.6	4.1	3.6	1.5
QUEBEC	576075	6.2	164340	77.4	9.7	21.1	6.5	116620	49.7	12.5	20.5	9.1	272505	1.4	10.6	4.6	2.4	0.7	5.2	6.6	1.8
RED DEER	46393	5.0	14830	88.1	4.5	7.0	3.2	11020	64.4	5.1	6.4	4.3	25710	1.3	7.7	2.3	2.7	0.2	2.8	6.9	1.4
REGINA	164313	8.6	48845	82.1	3.9	7.5	2.7	38030	59.2	5.2	8.1	3.7	86190	1.3	11.2	3.9	2.2	0.2	3.9	5.1	1.5
RIMOUSKI	37458	10.1	10350	75.8	13.8	30.6	9.2	7945	51.9	13.8	22.0	10.3	17600	1.3	10.4	4.5	2.5	0.7	6.7	5.8	1.8
RIVIERE-DU-LOUP	20521	10.3	5230	72.0	13.3	32.7	8.8	3610	44.5	15.4	20.8	13.2	8485	1.5	9.3	1.6	1.8	0.9	7.3	7.2	1.3
ROUYN	28648	-4.1	7995	75.0	10.9	20.5	7.8	5645	50.5	13.9	23.4	9.5	13240	1.4	6.1	4.3	1.6	0.4	6.1	5.5	1.9
SAINT JOHN	114048	0.9	31150	76.5	8.5	16.4	6.1	21045	47.4	8.7	12.3	7.0	51330	1.5	8.6	2.7	1.7	0.4	3.9	6.0	1.1
SAINT GEORGES	18778	13.5	5105	76.5	12.7	23.0	9.2	3505	49.5	14.0	17.5	12.2	8315	1.5	8.0	1.7	1.2	0.2	7.3	6.7	2.0
SAINT HYACINTHE	47440	5.4	13210	76.3	6.4	11.0	5.0	10050	50.6	9.5	16.3	6.9	22840	1.3	7.6	2.2	1.0	1.0	4.6	6.9	0.9
SAINT JEAN	60710	8.0	18540	78.5	7.6	12.0	5.9	11705	49.3	11.6	16.7	9.2	29550	1.6	7.2	2.0	1.2	0.1	5.3	4.8	1.1
SAINT JEROME	43786	6.3	12820	77.0	10.2	19.3	7.2	8585	48.5	13.7	20.0	10.5	20585	1.5	7.4	1.7	1.2	0.7	4.0	5.1	1.2
SARNIA	83951	3.2	25550	80.5	5.5	12.0	3.6	16160	50.1	9.9	14.2	8.0	41105	1.6	7.1	7.0	1.4	0.3	3.6	4.5	1.1
SASKATOON	154210	15.2	45825	81.5	5.3	9.5	3.7	35830	57.9	7.0	9.9	5.4	80790	1.3	9.5	3.9	2.2	0.4	4.8	6.3	1.5
SAULT STE.MARIE	86962	2.4	25850	79.3	3.6	9.5	1.8	16455	49.4	107	17.1	7.5	41680	1.6	5.6	3.5	1.4	0.1	3.9	4.4	1.0
SEPT-ILES	30057	-5.2	24735	79.7	3.6	9.6	1.8	15820	49.7	10.7	17.6	7.4	39935	1.6	5.6	3.5	1.4	0.1	3.9	4.5	1.0
SHAWINIGAN	62699	-0.8	17390	71.2	14.7	29.7	10.5	9690	37.3	20.1	30.5	14.9	25445	1.9	6.7	2.4	1.1	0.4	4.8	5.3	1.0
SHERBROOKE	117324	6.0	32040	75.7	10.3	21.4	6.9	25050	52.5	12.4	20.5	9.1	55320	1.3	8.1	2.7	2.3	0.9	7.4	7.7	1.5
SIMCOE	14326	0.9	4205	79.8	5.2	11.0	3.6	3155	55.3	5.7	7.2	5.2	7330	1.3	8.7	2.7	1.6	0.0	4.2	5.9	1.0
SMITHS FALLS	15045	-1.8	3825	73.7	7.3	15.8	4.8	3120	52.4	10.3	13.8	8.6	6840	1.2	6.0	2.0	7.6	0.1	3.5	7.2	1.9
SOREL	47030	6.4	13770	76.6	10.1	23.5	6.8	7440	40.8	17.2	28.1	2.0	20385	1.9	5.8	3.6	0.8	0.3	3.7	5.1	1.1
SPRUCE GROOVE	10326	5.0	3205	91.4	4.2	6.5	3.7	5095	1.7	12.5	4.4	1.2	4912	4.3	4.1	0.7	18.7	10.5	8.0	2.5	0.9
ST.CATHARINES-N.	304353	0.8	89090	77.8	5.5	13.1	3.4	59755	48.9	10.3	14.5	8.7	146405	1.5	6.9	3.3	1.1	0.2	3.8	4.1	11.1
ST.JOHN'S	154820	6.4	41155	76.1	11.5	22.9	7.9	30215	51.9	12.2	16.9	9.8	69860	1.3	10.2	3.7	1.8	0.3	5.2	7.5	0.9
STRATFORD	28064	1.7	8155	79.2	4.6	9.2	3.0	6640	57.5	7.3	10.1	6.0	14655	1.2	6.7	2.3	0.8	0.3	3.7	3.5	1.8
SUDBURY	149923	-4.5	41765	75.8	6.4	16.5	3.6	27045	47.9	10.8	16.9	8.0	67585	1.6	6.5	3.0	1.6	0.3	5.3	4.1	1.1
SUMMERSIDE	14950	-2.4	4025	75.7	10.9	24.9	6.5	2910	50.1	13.7	14.5	13.1	6830	1.4	7.2	1.5	0.9	0.0	3.3	5.2	1.0

SWIFT CURRENT	16574	2.7	4900	79.7	2.4	6.3	1.0	3365	51.0	5.5	8.7	3.9	8210	1.5	8.9	2.4	1.4	0.3	3.3	5.3	1.2
SYDNEY	87489	-1.2	21305	67.0	14.4	30.9	9.4	13210	38.7	16.5	26.1	2.3	33420	1.7	5.6	2.0	1.4	0.3	5.6	5.7	1.0
SYDNEY MINES	35348	-0.3	8410	66.5	13.9	28.8	9.4	5070	38.7	18.3	31.2	13.7	13100	1.7	5.5	1.6	1.3	0.2	5.8	5.9	0.7
TERRACE	32486	7.6	10415	87.2	5.4	12.1	3.3	6010	55.7	11.6	15.8	9.4	16210	1.8	7.9	3.7	1.5	0.3	5.0	4.0	0.9
THETFORD MINES	34698	2.4	9635	74.4	12.6	34.3	7.1	5635	41.4	12.3	22.5	7.8	14805	1.7	7.3	2.4	0.8	0.2	5.3	6.9	0.8
THOMPSON	14319	-17.3	4455	88.5	3.4	9.0	1.6	2860	63.9	7.9	9.6	6.9	7265	1.6	7.4	4.3	2.0	0.3	4.5	3.6	0.9
THUNDER BAY	121379	1.7	36880	79.1	5.7	11.6	3.9	25325	54.1	8.7	13.9	6.4	61695	1.5	6.8	2.8	2.0	0.3	4.1	5.4	1.1
TILLSONBURG	10487	11.5	2910	76.3	3.6	6.8	2.7	2530	57.4	6.7	10.0	5.5	5395	1.2	7.8	1.7	1.5	0.4	5.1	4.3	1.1
TORONTO	2998947	6.9	938500	82.2	3.4	7.6	2.3	740060	60.7	4.6	7.1	3.8	1667800	1.3	11.5	4.2	1.8	0.2	3.5	3.7	2.1
TRAIL	22939	3.7	7010	77.0	4.7	10.2	2.9	4080	46.7	9.4	14.9	7.1	10970	1.7	5.2	4.9	0.9	0.3	3.2	5.0	0.6
TRENTON	39106	1.0	11640	78.8	4.9	10.8	3.1	7525	51.0	10.4	14.1	8.9	18945	1.6	5.3	2.4	0.6	0.1	2.9	3.5	0.6
TROIS-RIVIERES	111453	5.1	30715	73.6	11.0	23.8	7.5	20130	43.7	15.3	25.8	10.7	48745	1.5	7.7	2.8	1.6	0.9	6.5	5.5	1.6
TRURO	39751	3.5	11060	74.6	7.9	11.2	7.0	7150	46.3	10.9	16.3	8.5	18005	1.6	6.3	2.5	1.5	0.3	4.8	3.5	1.4
VAL-d'OR	23495	7.3	7065	79.6	10.3	17.7	7.7	4325	49.2	14.0	20.6	10.3	11145	1.6	7.1	3.1	1.2	0.2	4.7	5.0	0.8
VALLEYFIELD	39491	2.6	11230	75.4	8.0	18.5	4.8	7180	45.1	15.4	25.0	11.1	17740	1.6	6.3	2.5	1.5	0.4	4.0	4.2	0.8
VANCOUVER	1268183	8.7	390040	79.3	4.7	9.5	3.4	291350	56.3	5.7	7.7	5.0	675945	1.3	9.7	3.7	1.9	0.1	3.8	5.0	1.6
VERNON	42158	15.3	6450	79.6	10.3	17.8	7.7	3965	49.2	13.9	20.1	10.3	10190	1.6	7.7	3.2	1.3	0.2	5.0	5.1	0.9
VICTORIA	233481	6.9	66010	73.9	4.7	8.6	3.5	50985	50.8	6.5	8.6	5.7	115980	1.3	8.3	4.2	2.2	0.2	4.4	6.2	1.6
VICTORIAVILLE	35920	9.8	9980	76.1	9.4	17.2	7.1	6610	47.6	13.2	22.1	9.0	16075	1.5	8.0	1.4	1.0	0.7	5.2	6.6	1.5
WALLACEBURG	11506	3.3	3300	79.2	8.2	16.7	5.5	2360	52.9	12.3	16.2	10.5	5550	1.4	4.9	2.5	0.7	0.5	2.9	3.3	0.6
WHITEHORSE	14814	11.3	9440	86.1	6.8	10.6	5.6	3805	72.0	6.4	7.7	5.9	8685	1.3	13.0	4.5	2.5	0.3	3.7	3.4	1.4
WINDSOR	246110	-0.6	68575	75.5	11.0	18.9	8.7	47705	49.0	12.5	16.6	10.9	113720	1.4	7.5	2.3	1.4	0.2	4.4	4.9	1.3
WINNIPEG	584842	1.1	173210	79.6	4.8	9.3	3.4	136150	56.9	5.6	7.8	4.6	307220	1.3	9.3	3.3	2.0	0.2	4.2	5.2	1.5
WOODSTOCK	26603	-0.6	7655	78.4	6.1	12.5	4.2	6055	56.1	8.6	12.3	7.1	13495	1.3	6.8	1.8	2.6	0.5	3.5	4.7	0.8
YORKTON	15339	6.5	4095	73.7	3.4	7.5	2.1	3180	51.6	8.0	12.6	5.9	7210	1.3	9.0	1.9	2.8	0.5	3.9	7.1	1.9

1981 DATA MATRIX - CONTINUED (For explanation of codes see Table 4., pp.35,36)

Name	R22	R23	R24	R25	R26	R27	R28	R29	R30	R31	R32	R33	R34
ABBOTSFORD	2.7	10.5	10.8	10.0	3.1	2.1	4.0	9.0	5.7	2.2	0.7	26.7	61.7
ALMA	15.3	10.3	12.6	3.2	8.3	2.6	5.3	7.4	3.3	1.8	1.5	30.3	60.0
ASBESTOS	13.3	6.6	9.4	13.3	7.7	3.3	12.8	5.5	5.5	2.4	1.2	38.5	47.2
BAIE-COMMEAU	18.1	5.9	11.9	1.8	11.5	2.5	6.5	7.1	3.5	2.3	1.4	34.8	64.0
BARRIE	19.2	12.2	11.7	2.8	3.1	3.1	9.3	6.0	5.3	2.1	1.2	30.1	65.5
BATHURST	20.1	10.9	11.8	7.8	4.4	1.7	6.5	6.1	3.4	1.8	1.3	25.2	65.7
BELLEVILLE	17.5	9.9	14.5	2.9	4.0	2.6	9.3	5.8	5.0	1.9	1.0	30.7	65.7
BRANDON	17.4	12.4	16.1	2.1	2.5	1.9	5.5	7.2	4.6	0.9	1.0	23.6	39.6
BRANTFORD	17.1	9.4	10.5	2.9	4.7	7.6	14.2	4.2	3.0	2.8	1.2	37.9	57.3
BROCKVILLE	17.1	8.3	11.6	4.7	4.5	2.9	10.6	6.1	3.5	2.2	1.1	31.0	62.7
CALGARY	21.9	10.1	10.8	1.6	1.7	2.1	5.0	9.7	3.7	1.5	1.0	24.7	72.1
CAMPBELL RIVER	16.9	8.1	11.4	13.2	5.4	1.7	6.8	11.1	4.3	1.3	0.9	32.6	53.5
CAMPBELLTON	15.3	10.2	15.7	2.2	2.9	1.1	6.6	9.1	4.1	0.8	0.6	25.1	69.9
CAMROSE	17.6	9.4	13.5	5.7	2.6	3.9	5.7	11.7	3.0	1.2	0.7	28.9	64.4
CARBONEAR	11.8	9.5	10.2	4.4	17.7	0.9	5.0	13.2	4.1	2.3	0.8	44.1	49.2
CHARLOTTETOWN	17.8	9.0	14.5	5.5	2.2	1.2	4.2	7.0	4.5	1.4	1.1	21.5	71.1
CHATHAM	17.6	9.7	13.2	5.3	3.5	4.8	10.4	5.9	3.3	2.0	1.1	31.1	63.4
CHICOUTIMI-JONQ.	16.1	9.2	12.7	2.0	2.4	3.0	6.8	11.4	5.6	1.5	1.1	32.0	66.0
CHILLIWACK	14.4	8.9	20.7	9.0	3.6	1.7	5.2	9.6	4.4	1.6	0.5	26.8	62.7
COBOURG	15.5	8.2	12.2	4.7	6.2	4.5	12.6	5.8	3.5	3.4	1.0	37.0	56.2
COLLINGWOOD	14.3	7.9	12.9	1.5	7.1	6.2	14.9	7.6	2.5	2.8	0.7	41.8	53.9
CORNER BROOK	18.4	11.8	12.1	2.6	7.8	1.1	5.1	7.5	4.6	3.0	0.9	30.0	65.5
CORNWALL	17.8	5.6	13.1	1.7	10.2	2.0	9.1	6.7	3.6	2.5	1.2	35.5	57.3
COWANSVILLE	15.8	6.4	14.3.	1.5	11.9	2.5	12.4	4.8	2.3	2.8	3.1	39.9	57.8
COURTENAY	14.0	8.4	21.4	10.3	2.7	1.2	6.2	9.2	4.9	1.3	0.9	26.5	62.3
CRANBROOK	19.9	10.4	16.1	4.8	3.3	1.4	5.1	8.5	6.4	2.5	0.8	28.1	66.2
DAWSON CREEK	20.6	10.6	13.4	3.4	2.9	1.1	7.4	10.7	5.3	1.7	0.9	30.0	65.7
DOLBEAU	13.8	9.5	12.6	11.1	9.8	1.6	6.7	5.9	3.9	1.3	0.7	30.1	58.1
DRUMMONDVILLE	15.3	10.3	11.2	2.0	9.1	3.7	12.9	6.3	3.3	1.5	2.7	39.4	57.8
EDMONTON	21.4	9.9	11.2	2.3	2.2	2.8	5.4	9.2	4.3	1.8	1.1	26.9	68.5
EDMUNDSTON	17.1	7.5	14.1	5.3	5.8	1.3	8.7	8.5	5.1	1.1	0.9	31.5	61.2
FERGUS	14.9	9.7	10.8	4.6	5.8	4.9	10.7	5.6	2.5	1.8	2.5	34.0	59.1
FLIN FLON	13.1	6.2	12.1	14.8	6.3	2.3	6.9	7.3	4.5	3.8	1.4	32.6	51.7
FORT McMURRAY	16.6	5.7	11.1	5.2	3.4	3.4	8.6	14.6	4.4	1.8	1.6	37.8	55.5
FORT ST.JOHN	16.4	11.1	11.1	7.0	2.2	1.9	5.8	12.6	6.3	2.9	1.4	33.2	57.9
FREDERICTON	21.0	9.7	14.0	3.5	1.8	1.1	4.9	6.5	3.4	1.2	1.1	20.0	74.9
GRANBY	16.9	9.1	10.3	2.2	8.4	4.2	16.8	10.2	3.0	2.1	1.7	46.4	56.0
GRAND FALLS	18.1	9.2	11.2	3.3	8.3	1.3	4.4	6.4	4.5	2.8	2.1	29.8	64.4
GRANDE PRAIRIE	19.3	10.3	11.5	5.3	2.9	1.6	6.8	9.6	5.6	1.9	1.3	29.8	63.4
GUELPH	17.5	8.2	11.5	2.9	4.9	5.4	11.2	4.1	2.8	2.0	0.7	31.2	63.9
HAYLEIBURY	17.5	10.4	12.8	7.7	3.8	2.5	6.2	7.1	3.5	1.2	1.5	25.9	64.0
HALIFAX	21.7	9.8	17.8	1.3	1.4	1.0	5.0	5.3	3.8	2.0	1.3	19.8	77.6
HAMILTON	18.5	9.5	11.2	2.1	6.6	4.8	9.2	5.3	3.6	3.3	1.1	33.8	62.4
HAWKESBURY	12.3	11.2	9.9	1.1	16.8	3.7	14.9	5.6	2.1	2.6	1.2	46.9	51.9
JOLIETTE	15.9	10.2	12.0	2.5	5.9	2.4	11.3	5.7	3.7	1.7	1.2	32.0	64.7
KAMLOOPS	17.1	10.1	14.7	3.4	3.0	1.6	6.4	10.4	5.9	1.9	1.2	30.5	64.8
KAPUSKASING	15.8	6.4	14.0	6.6	13.0	2.2	6.8	7.7	3.0	1.7	1.0	35.5	56.6
KELOWNA	16.7	11.6	12.8	5.4	3.2	1.7	8.1	11.4	3.3	2.2	0.6	30.5	62.7
KENORA	17.2	8.2	15.0	3.0	2.7	0.8	8.2	8.1	7.7	1.3	1.1	30.0	64.8
KENTVILLE	17.5	9.8	12.1	9.5	7.0	0.8	5.3	7.9	4.6	1.7	0.8	27.2	61.4
KINGSTON	17.3	8.6	19.8	2.8	4.4	1.8	5.0	4.5	6.3	1.1	0.9	24.1	73.5
KITCHENER	18.0	9.7	10.6	1.8	6.0	5.8	13.3	4.6	2.9	2.7	1.0	36.3	60.2
LA TUQUE	13.6	8.4	13.4	3.2	13.6	1.8	7.8	6.8	4.4	1.6	2.2	38.2	56.6
LABRADOR CITY	16.6	5.4	10.6	16.2	4.3	4.9	16.3	8.2	6.2	2.3	1.2	43.0	52.2

LACHUTE	14.9	7.8	12.7	5.0	11.5	2.2	11.4	5.1	5.3	1.4	0.9	37.9	56.1
LEAMINGTON	13.3	8.0	9.7	19.1	8.8	3.0	6.6	5.3	2.6	3.4	0.9	30.6	47.2
LEDUC	18.6	9.4	12.9	3.0	1.7	4.4	7.3	9.0	6.3	2.0	0.6	31.4	65.3
LETHBRIDGE	17.9	11.6	13.5	2.8	3.9	2.1	6.0	8.8	3.6	2.2	1.0	27.6	67.8
LINDSAY	17.7	8.2	13.7	4.4	2.9	2.8	14.2	5.4	3.9	1.8	1.7	32.7	60.9
LONDON	20.1	10.7	12.9	2.6	2.3	2.8	8.5	5.1	3.3	2.3	1.3	25.6	70.6
LUNENBURG	11.3	9.4	8.0	13.4	12.3	1.8	11.7	9.2	5.4	1.7	1.0	43.1	42.2
MAGOG	13.2	9.3	11.7	1.4	17.8	1.6	11.0	6.2	2.1	2.8	3.2	32.5	53.2
MATANE	20.3	8.5	14.7	3.7	5.1	1.1	6.0	8.0	4.6	1.0	0.5	26.3	69.4
MEDICINE HAT	14.1	11.4	12.6	9.7	3.0	2.3	5.4	11.6	4.8	2.2	1.6	31.0	57.4
MIDLAND	13.5	7.2	10.5	3.3	3.7	5.9	18.8	6.6	4.0	2.5	1.3	42.7	51.9
MONCTON	22.9	11.6	12.9	1.4	2.6	1.7	6.2	5.8	5.2	2.6	1.0	25.0	71.9
MONTREAL	22.2	9.3	11.2	0.7	3.4	2.5	10.7	4.3	3.9	2.0	1.6	28.4	70.2
MOOSE JAW	14.9	8.4	23.0	4.5	1.6	0.8	5.7	9.5	4.6	1.1	0.9	24.3	69.7
NANAIMO	17.6	11.3	13.3	5.8	4.6	2.0	5.1	10.1	5.0	2.3	0.8	30.1	62.8
NEW GLASGOW	15.3	10.8	10.7	4.1	4.7	5.7	11.9	6.8	4.6	2.9	0.9	37.7	56.5
NORTH BATTLEFORD	14.7	11.4	16.0	5.2	0.8	1.8	5.2	8.2	3.1	1.6	1.6	22.4	70.9
NORTH BAY	18.5	10.8	16.6	1.4	2.2	2.8	7.0	6.4	5.8	1.3	1.2	26.7	70.6
ORANGEVILLE	17.9	11.1	11.1	1.6	3.2	4.3	11.3	4.6	6.3	2.7	2.6	35.2	60.8
ORILLIA	16.7	11.7	14.8	2.2	4.4	4.8	7.0	6.0	3.5	1.7	1.0	28.5	68.3
OROMOCTO	15.5	4.4	47.8	2.1	1.8	1.0	4.2	3.4	2.8	1.3	1.8	16.4	80.9
OSHAWA	19.5	9.3	10.9	1.4	2.7	4.6	15.7	4.9	3.4	2.5	1.5	35.4	61.3
OTTAWA-HULL	26.3	8.2	13.9	1.6	1.3	0.7	3.9	4.4	2.9	0.7	1.4	15.4	82.0
OWEN SOUND	17.9	10.1	11.5	4.0	3.1	3.7	8.1	6.0	3.9	2.1	3.7	30.6	62.9
PEMBROKE	16.4	9.6	14.2	4.4	4.9	2.1	9.1	7.6	4.5	2.5	1.9	32.8	61.5
PENTICTON	17.0	11.1	15.3	14.0	2.8	2.4	7.0	10.1	3.3	1.8	0.7	28.2	65.0
PETAWAWA	12.3	5.7	48.0	2.2	1.6	0.8	4.3	5.7	2.7	1.1	1.0	32.4	79.2
PETERBORUGH	17.8	11.2	13.1	3.6	2.5	4.1	10.4	6.0	2.8	1.9	1.2	29.1	66.0
PORT ALBERNI	12.0	7.1	12.7	12.9	14.5	2.2	6.3	5.7	4.2	3.9	1.1	38.0	47.2
PORTAGE LA PRAIR.	13.8	8.1	17.2	13.1	3.9	0.6	4.9	6.8	2.5	0.9	1.1	20.9	64.7
POWELL RIVER	12.6	6.0	11.5	9.3	13.7	2.3	7.7	9.2	5.4	2.6	1.1	42.0	47.4
PRINCE ALBERT	16.6	9.7	15.6	6.5	2.5	1.3	5.3	8.6	4.7	1.8	0.9	25.2	67.4
PRINCE GEORGE	19.2	9.8	12.1	3.4	5.5	1.9	7.0	9.7	5.4	3.1	0.9	33.4	61.9
PRINCE RUPERT	15.4	5.8	9.4	8.1	14.3	1.5	5.8	7.5	6.1	4.1	1.3	40.6	49.5
QUEBEC	22.7	9.0	14.2	1.1	2.4	1.4	5.5	5.0	3.5	1.2	1.1	20.3	78.0
RED DEER	17.4	12.3	13.2	5.1	1.6	1.3	5.3	11.4	4.3	1.4	1.2	26.7	67.1
REGINA	23.8	10.4	12.9	2.0	1.9	1.6	4.5	7.2	3.4	1.8	1.1	21.7	75.1
RIMOUSKI	22.2	9.6	13.6	2.5	1.2	1.2	4.0	6.7	3.6	0.8	1.4	18.9	77.9
RIVIERE-DU-LOUP	16.5	9.7	13.9	3.4	4.2	1.8	6.0	6.0	5.5	1.6	0.8	26.0	69.6
ROUYN	20.0	9.9	14.3	7.3	2.0	1.7	4.7	6.4	5.1	1.0	1.0	21.9	70.2
SAINT JOHN	21.0	9.6	13.0	1.4	3.4	2.7	5.7	8.4	4.2	3.5	1.3	29.2	68.1
SAINT GEORGES	14.7	11.2	13.2	3.7	3.8	2.7	12.0	6.9	3.2	0.7	0.4	29.8	66.2
SAINT HYACINTHE	15.7	9.8	11.2	2.3	8.2	2.9	12.5	4.6	3.8	2.2	1.7	36.0	61.0
SAINT JEAN	15.3	8.4	17.9	1.9	6.8	2.9	11.8	5.4	3.7	1.8	1.6	34.0	63.4
SAINT JEROME	17.3	11.1	13.1	1.0	6.0	2.8	13.5	6.5	4.1	1.3	1.1	35.4	62.9
SARNIA	16.8	8.9	12.8	2.5	7.0	2.7	6.1	9.3	3.2	2.1	1.8	32.3	39.6
SASKATOON	19.4	10.7	13.3	2.8	1.9	1.5	5.5	7.7	3.8	1.7	1.2	23.4	72.2
SAULT STE.MARIE	16.6	8.4	13.4	1.8	10.3	3.9	6.9	7.8	3.9	3.8	0.9	37.6	58.4
SEPT-ILES	16.9	8.4	13.5	1.7	10.0	3.8	6.5	7.3	3.5	3.7	0.9	35.8	59.1
SHAWINIGAN	16.8	8.5	11.1	2.7	14.0	2.3	10.0	5.6	3.8	1.4	1.5	38.5	58.1
SHERBROOKE	17.3	9.2	13.1	2.0	5.4	2.4	8.7	5.1	2.8	1.3	1.3	27.1	70.2
SIMCOE	15.1	10.7	13.0	6.7	5.7	4.7	7.1	5.1	2.7	2.0	1.4	28.8	62.9
SMITHS FALLS	16.9	9.1	11.6	2.5	3.2	4.0	6.6	5.7	5.9	2.3	1.7	29.5	65.9
SOREL	15.3	8.0	11.4	1.5	9.0	7.7	12.1	6.9	3.4	2.6	1.0	42.9	55.1
SPRUCE GROOVE	18.7	10.5	8.0	2.5	0.9	2.2	7.1	11.3	5.7	2.0	2.3	31.5	64.7
ST.CATHARINES-N.	16.1	19.2	13.8	3.0	6.4	6.5	9.9	5.4	3.7	2.6	1.0	35.4	59.7
ST.JOHN'S	22.0	9.4	13.2	2.2	2.9	1.0	3.9	6.7	3.9	1.8	1.4	21.7	74.4
STRATFORD	17.8	9.4	13.0	2.6	3.1	7.6	14.8	4.7	2.8	2.2	1.1	36.3	59.2
SUDBURY	17.4	9.2	13.1	13.2	3.7	2.0	6.2	7.1	4.0	2.1	1.0	26.2	61.6
SUMMERSIDE	14.9	7.6	24.4	4.4	6.1	0.9	5.8	6.7	4.5	1.6	1.4	27.0	66.2

SWIFT CURRENT	15.5	11.6	14.1	0.7	1.2	1.4	5.8	7.4	3.9	1.5	1.5	22.7	64.8
SYDNEY	14.4	10.3	13.5	7.8	5.3	1.7	5.1	9.7	4.1	2.3	1.4	29.7	60.0
SYDNEY MINES	12.8	9.7	12.1	6.6	9.0	2.0	4.4	8.5	5.3	4.9	1.4	35.6	55.7
TERRACE	18.7	8.1	13.7	8.9	13.1	4.1	8.3	11.2	5.6	5.1	1.2	48.6	63.8
THETFORD MINES	15.0	8.1	11.0	2.4	4.6	3.1	10.4	5.2	5.9	1.6	0.8	31.6	57.8
THOMPSON	15.7	5.8	12.8	14.5	5.6	2.1	6.5	6.3	4.2	1.8	0.6	27.1	57.4
THUNDER BAY	16.8	9.0	13.7	3.3	6.3	2.6	7.5	6.7	5.3	3.3	1.1	32.9	61.9
TILLSONBURG	15.4	12.8	9.9	10.6	3.2	3.0	7.9	5.5	3.0	4.3	0.6	27.4	60.0
TORONTO	24.2	9.5	10.2	0.9	2.5	2.9	9.0	4.9	3.0	2.6	1.6	26.5	70.9
TRAIL	15.2	7.7	12.7	3.7	11.2	0.6	0.3	10.4	3.4	2.3	1.9	30.2	55.7
TRENTON	15.0	8.3	21.4	3.5	5.0	3.7	12.4	5.8	3.9	2.5	1.2	34.7	60.5
TROIS-RIVIERES	17.1	9.3	11.9	1.0	8.8	2.3	9.4	5.9	3.3	1.7	1.4	32.9	65.1
TRURO	15.6	11.2	12.5	6.2	5.3	1.5	10.0	7.0	5.1	2.2	0.9	32.2	59.7
VAL-d'OR	20.1	8.6	13.1	11.3	0.3	2.0	5.3	7.4	3.8	1.2	1.1	24.3	63.9
VALLEYFIELD	15.8	9.2	12.4	1.6	13.4	2.6	11.3	6.1	3.0	2.3	1.5	40.3	57.2
VANCOUVER	21.8	10.6	12.6	2.1	3.2	2.1	6.2	6.4	3.9	2.7	1.1	25.7	71.0
VERNON	20.5	8.5	13.0	10.2	4.4	2.1	6.4	7.0	3.9	2.7	1.7	28.4	65.4
VICTORIA	20.8	9.8	17.3	2.6	1.9	1.6	4.5	7.0	3.6	1.4	1.1	21.1	75.0
VICTORIAVILLE	16.0	11.0	11.3	2.8	3.6	3.4	15.5	5.8	3.2	2.2	1.0	34.8	62.7
WALLACEBURG	13.7	8.2	10.7	2.2	13.5	11.7	8.9	4.2	3.0	2.5	0.9	44.8	48.2
WHITEHORSE	21.5	6.8	12.9	3.8	0.8	0.9	5.6	8.9	5.5	1.7	1.4	24.9	70.1
WINDSOR	17.4	8.9	13.6	1.7	2.9	6.5	13.6	5.1	3.7	2.1	0.9	34.8	62.0
WINNIPEG	22.1	9.7	12.9	1.3	2.4	2.8	9.0	4.9	4.0	1.9	14.4	26.5	70.7
WOODSTOCK	18.0	8.3	12.3	2.4	6.7	7.2	10.7	4.2	3.1	3.3	1.3	36.6	59.3
YORKTON	16.9	11.6	15.3	3.1	1.2	2.7	5.2	8.2	3.9	2.1	1.3	24.7	71.0

APPENDIX 2. FACTOR ANALYSIS

The first step in the principal-component analysis and in factor models is the standardization of variables (Figure 4.). This was obtained by transforming the data matrix A(n x k) where, *n*, cities (rows) and, *k*, variables (columns) into a matrix of standardized scores Z(n x zk) where, *zk*, standardized variables. Subsequently, the standardized data matrix, Z, was used to calculate the correlation coefficient matrix C(k x k). The correlation matrix C, indicates the degree of intercorrelation between all the variables, *k*. This is the most frequently applied standard principal-component technique known as R-technique. The major advantage of it is that by correlating *k*-columns with each other, as a result square k x k correlation matrix C can be constructed. This matrix shows similarities in the way the variables vary among cities and the resulting k coefficients for each variable can be used for further transformations.

The next step is to calculate factor matrix R(k x F) where, *k*, and *F* factors, which when examined may reveal that many of the variables are not independent of each other but are highly correlated. Then, a number of different clusters of variables could be identified. Identification of these clusters variously known as ***factors, components,*** or ***dimensions,*** is achieved using the factor analysis procedure.

An understanding of the patterns defined by the factor analysis can be enhanced through a geometric interpretation. Each city from, *n*, row of the data matrix A(n x k), can be thought of as defining a coordinate axis of a geometric space. Then, in this space each characteristic (*k* column) can be considered a point, located according to its value for each city (Figure 33.a). If for each point a line is drawn from the origin to the point , then a vector representation of the data can be computed. The *k* characteristics of the, *n*, cities similarly plotted as vectors into imaginary, *k*, dimensional space of the, *k*, characteristics (number of dimensions equals the number of variables), would describe a vector space. Considering any two vectors *k*, and *k*, representing any two of these characteristics (Figure 33.), the angle between these vectors measures the relationship (correlation) between the two characteristics for the *n* cities. The closer to 0 the angle is, the stronger the relationship between the characteristics.

The configuration of the, *k*, vectors for, *k*, characteristics will then reflect the data interrelationships (Figure 33.b). Moreover, characteristics that are highly intercorrelated will cluster together. By inspecting the configuration expressed as mathematical artifacts called factor loadings, *f*, the distinct clusters can be discerned (if such clusters exist of course) and

> "...these clusters index the patterns of relationship in the data; each pattern is indicated by a cluster" (Rummel, 1967, p.444).

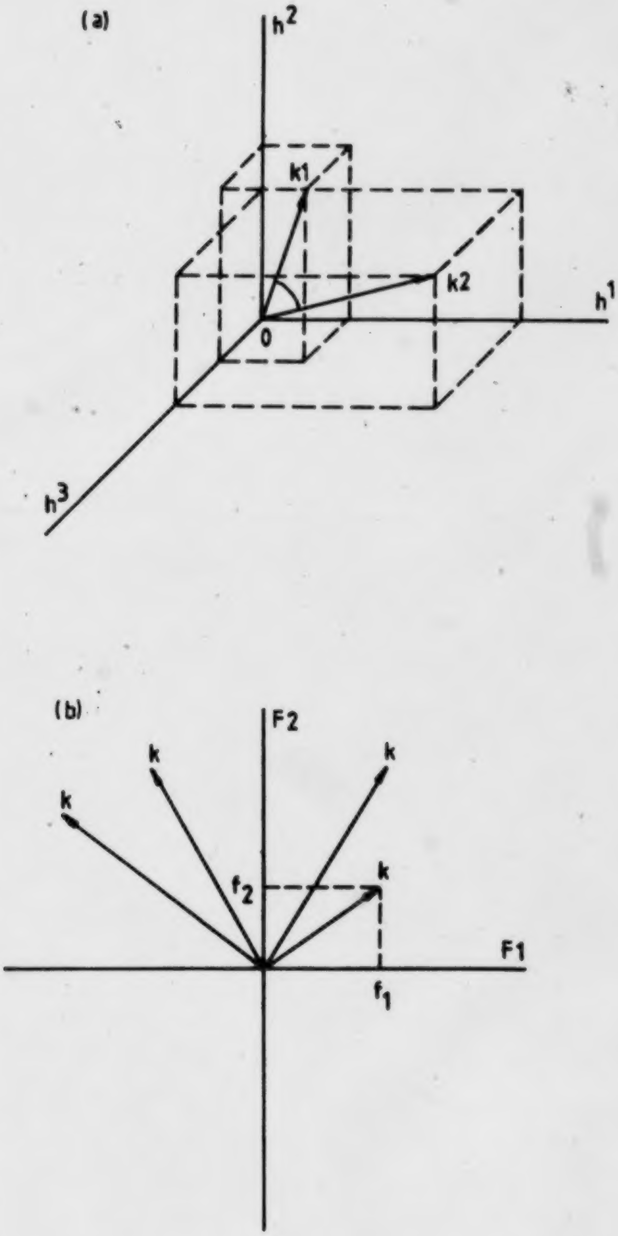
Factor analysis enables clusters of vectors to be defined when the number of cities or variables exceeds the graphical limit of three dimensions. It defines a set of basic dimensions for the *k* columns of the data matrix by projecting mathematically an axis through each cluster F. The projection of each vector point on the factor axes defines the clusters. These projections of each vector are called factor loadings, *f*, and the factor axes (factors F) when empirically interpreted are often called dimensions.

The square of these factor loadings will indicate the proportion of variation in the variables (called the variation in the data matrix) that is associated with the variation in the component. The sum of the squared factor loadings (which is referred to as an eigenvalue) is used to determine the proportion of total variation summarized by this component (which is referred to as a cumulative explanation).

The most important stage of the principal-component procedure is transformation of the original data matrix A(n x k) into a reduced factor matrix R(k x F). The question therefore arises: "How many factors *F*, should be calculated from the data matrix A ?"

In theory, the number of factors extracted, *F*, equals the number of original variables, *k*. However, the first factor accounts for the largest proportion of the cumulative explanation. As each successive factor is extracted, the explanation it contributes decreases, so that the last few components account for a minimal proportion of the total variation in the data matrix. Since the variation accounted for by usually about half of all possible factors (Yeates, 1974,

Figure 33. A Graphical Representation of a Resolution Vector: a) Three dimensional representation of the patterns defined by factor analysis. b) Projection of *k* variables in a two factor space.


(a)
h^2
k1
k2
h^1
0
h^3
(b)
F2
k
k
k
k
f_2
F1
f_1

p.221) is very small, there is the problem of where to cut the extraction, especially, since factors which account for a small proportion of the total explanation may consist of errors originating from measurment of variables in the data matrix.

Perhaps, the best review of the various methods for determining the number of factors to be extracted in the factor analysis procedure was presented by Rummel (1970). However, only a few of them can be applied in geography. In this thesis King's criterion (King, 1969, p.174) will be adopted in order to determine the size of the factor matrix. The criterion states, that all factors which contribute less than 5% to the overall cumulative explanation should be excluded from further examination. The factors which contribute below this proportion of the total explanation must contain a large random error variance. Therefore, there is a very high danger of an interpretation leading to wrong results.

The factor matrix R(k x F) where, *k*, variables and, *F*, factors has a number of useful features for interpretation. Firstly, the number of factors (dimensions) is the number of independent (uncorrelated) patterns of relationships among the variables. These may be thought of as indexing different clusters of characteristics in the data matrix A and therefore, when empirically interpreted, expose attributes by which cities can be grouped. Secondly, the factor loadings, *f*, measure which variables, *k*, are involved in which factor pattern, *F*, (dimension) and to what degree.